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Producing Large Cast Steel Locomotive Frames

The Molding, Casting and Annealing Practice Pursued at the Plant of the Ohio Steel Foundry Co., Lima, O., Where This Work Has Been Highly Specialized

DURING the past decade the steel foundry industry has undergone remarkable development. The status of steel castings for severe service has been firmly established and users of castings and forgings, who 10 years ago were unwilling to experiment with steel because of its liability to show defects under strain, now are strong advocates of the use of this material as evidenced by its extensive employment in the construction of locomotives. One plant, which has played an important part in the development of steel casting practice is that operated by the Ohio Steel Foundry Co. at Lima, O. Established in 1907, this company has developed a large trade in the production of castings for locomotives and cars. The present output averages about 1,500 tons per month, and consists largely of heavy castings, such as locomotive frames, frame braces, corner castings, fire box mud rings, wheel centers, guide yokes, bolsters, center bearings, etc. On account of the size of the castings, traveling cranes play an important part in the operation of the foundry. Seven cranes, operating in two bays, each 600 feet long, perform all of the hoisting and conveying, and hand-trucking is eliminated entirely. The suc-

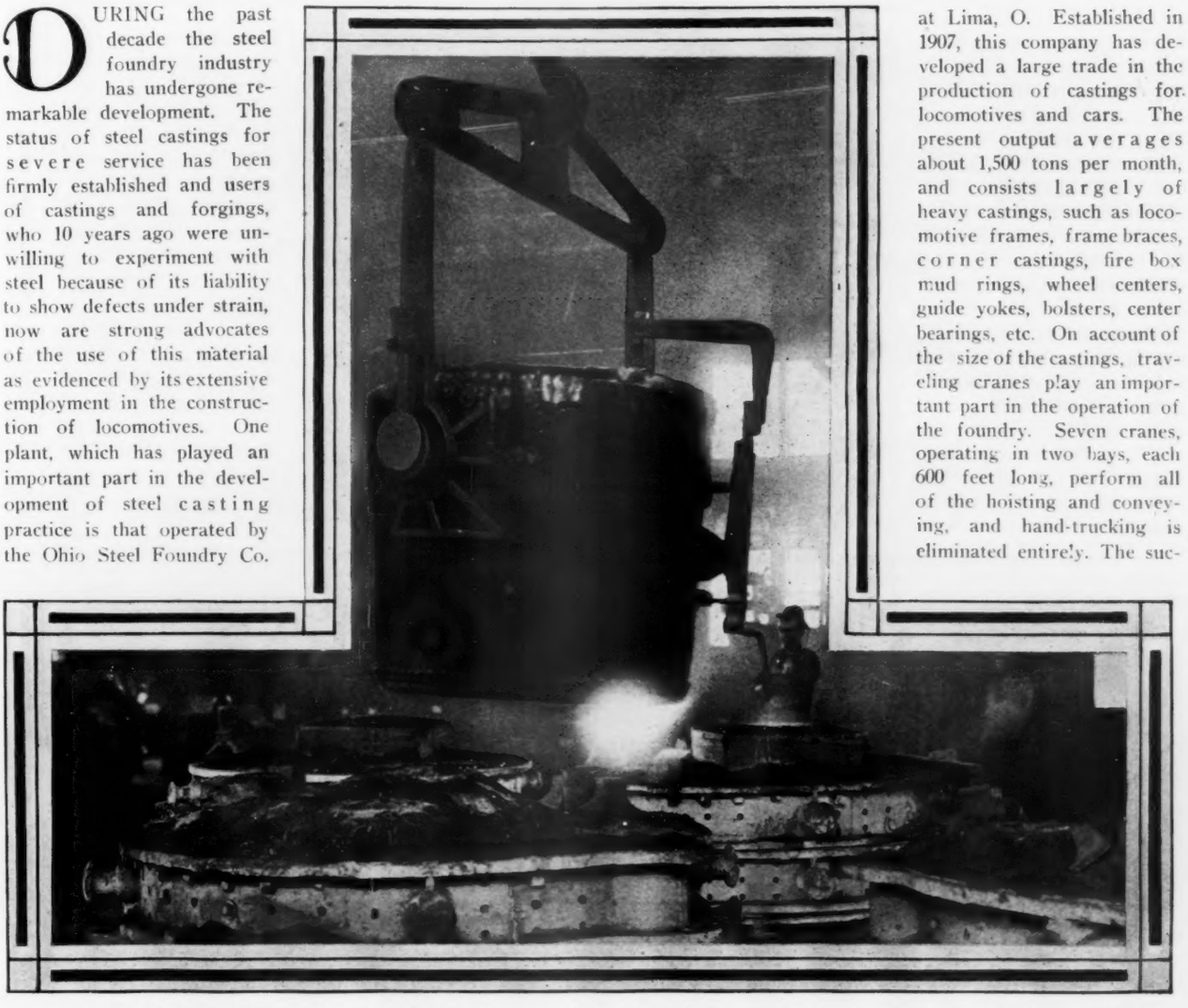


FIG. 1—POURING MOLDS FOR LOCOMOTIVE DRIVING WHEEL CENTERS FROM 20-TON, BOTTOM-POUR LADLE

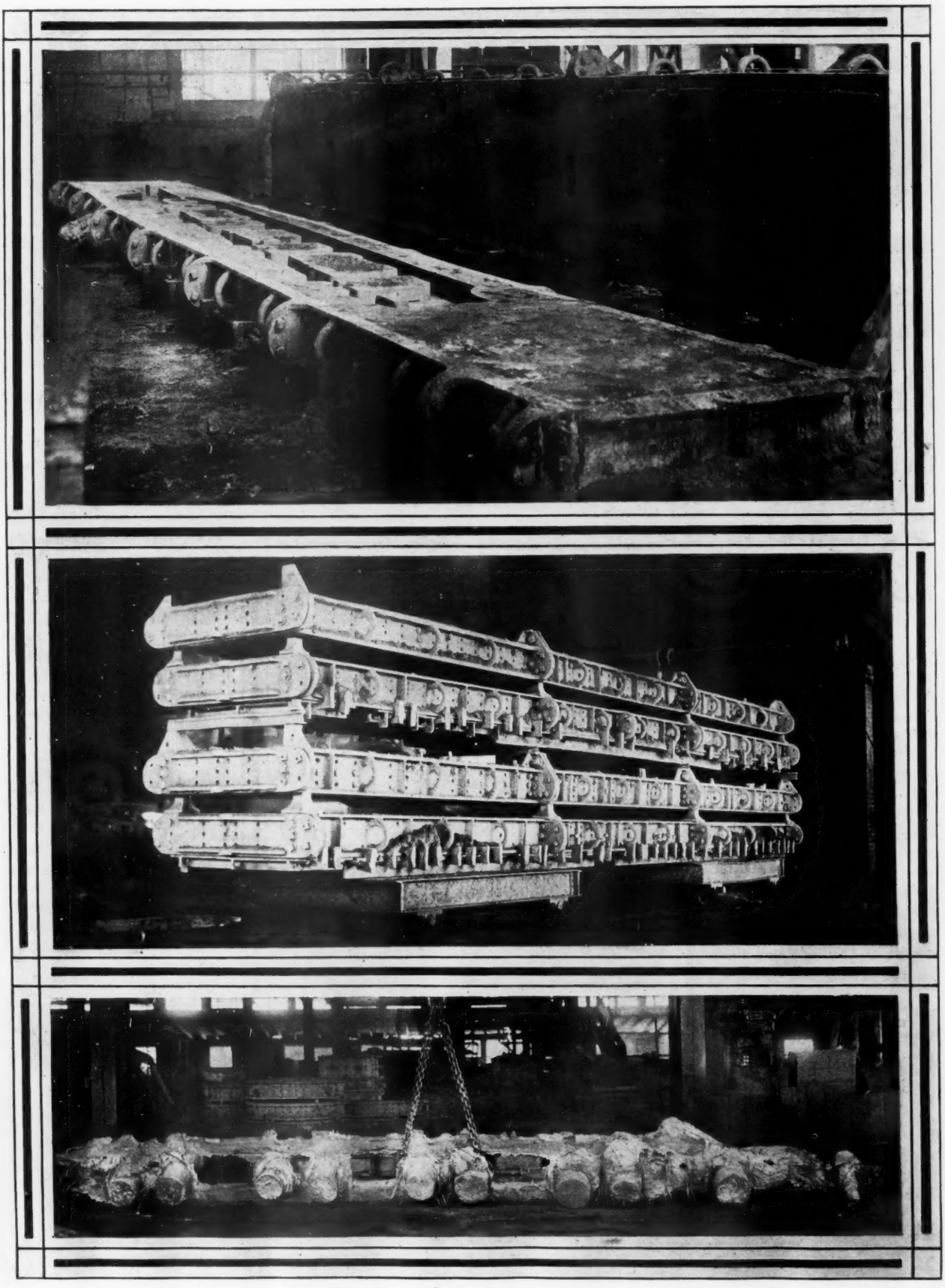


FIG. 2—DRAG AND COPE OF MOLD FOR VANADIUM STEEL LOCOMOTIVE FRAME
FIG. 3—MOLDS FOR TWO LOCOMOTIVE FRAMES AS THEY APPEAR AFTER COMING FROM MOLD DRYING OVEN, SHOWN IN THE BACKGROUND
FIG. 4—FRAME AS SHAKEN-OUT. NOTE THE HEAVY HEADS AND FILLING PIECES IN THE PEDESTAL JAWS

FIG. 5—LOCOMOTIVE FRAME BEING LIFTED FROM THE ANNEALING PIT

cess of the crane service has been due largely to the general arrangement of the molding and cleaning floors, which has facilitated the routing of the work through the plant. By directing the castings in a straight course from the molding floor to the shipping department, redoubling over old paths has been avoided, and the work of the cranes has been simplified. The general plan of the plant is shown in Fig. 11. The molding is done in the main bay, 75 x 600 feet, which is served by four cranes, two of which are of 25 tons capacity each. These cranes, built by the Alliance Machine Co., are at the north of the runway, so that they may serve the 20-ton open-hearth furnace located at the extreme end of the building. The other two cranes each are of 10 tons capacity and are used at the south end of the bay to shake-out castings, carry molds, castings, sand and empty flasks, from place to place, as needed. Wall cranes are provided at various points in the bay to facilitate the handling of small molds. In the small bay at the right of the molding floor are various auxiliary departments, including the core room, sand-preparing plant, machine shop equipped for heavy work, and three large mold drying ovens. As the molds are finished they are conveyed by cranes to wide gage flat cars, on which they are moved into the drying ovens. After drying and pouring, the molds are conveyed to the south end of the bay, where the castings are shaken-out. The empty flasks are returned to the molding floor and the castings are delivered to one side of the bay, where they are picked up by cranes serving the cleaning room. The sand which is shaken-out from the molds is worked over by a grab bucket operated by one of the 10-ton cranes. Sprues, nails, gaggers, etc., which are

FIG. 6—AFTER THE FRAME HAS BEEN ANNEALED IT IS STRAIGHTENED IN A 500-TON HYDRAULIC PRESS

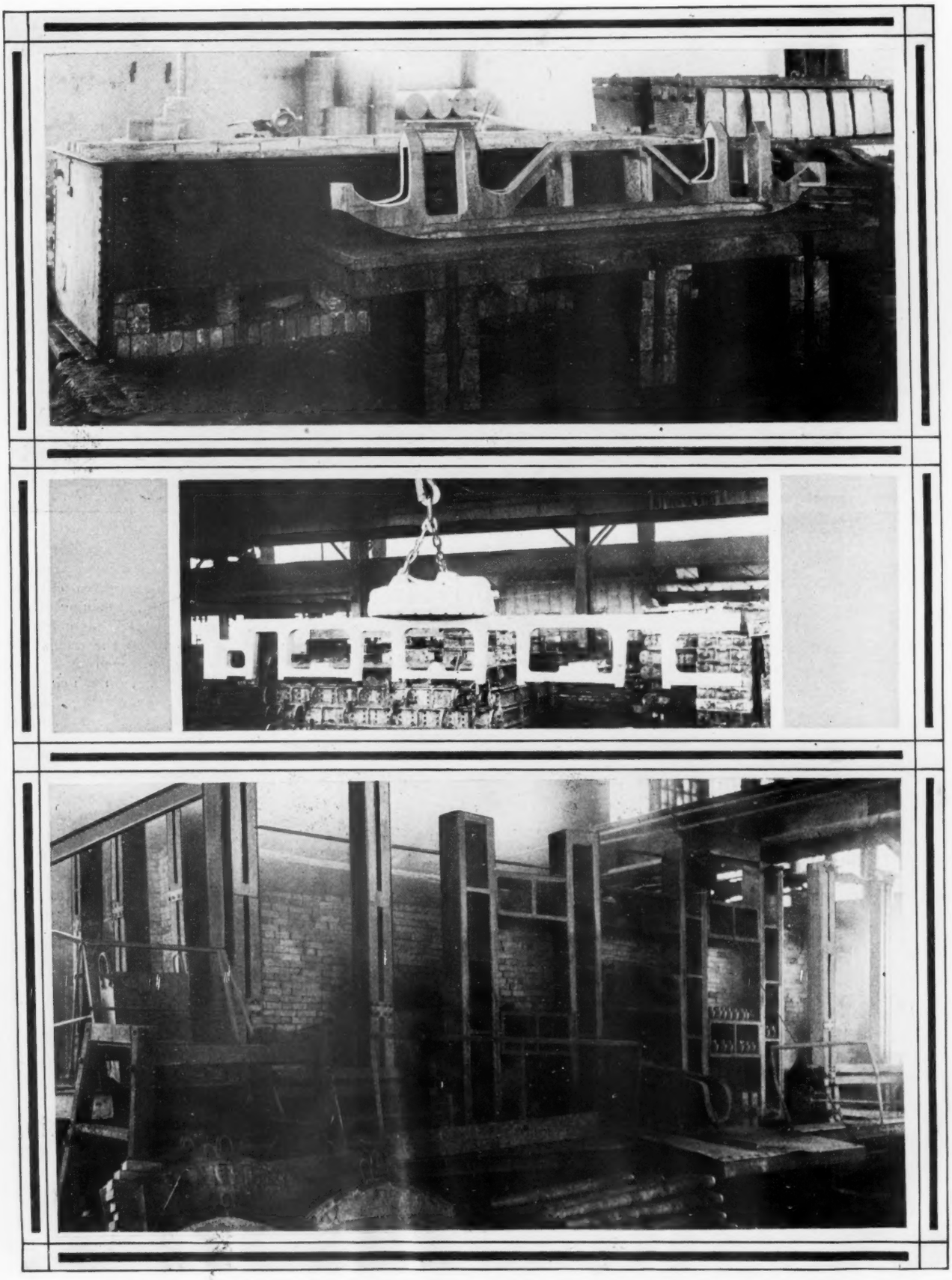


FIG. 7—SIDE FRAME FOR NEW YORK SUBWAY CARS. A DOUBLE FURNACE FOR ANNEALING THESE FRAMES IS SHOWN IN THE BACKGROUND
FIG. 8—STRAIGHTENED FRAME READY FOR SHIPMENT
FIG. 9—VIEW OF TAPPING SIDE OF 20-TON OPEN-HEARTH FURNACE

separated from the sand during the mixing operation are collected in large buckets. The prepared sand is conveyed to the molders in wooden boxes, 5 feet wide, 10 feet long and 4 feet deep.

How Castings are Cleaned

The cleaning and finishing departments occupy the east bay, which is 60 feet wide and 600 feet long. The castings which have been shaken-out of the molds are picked up by a magnet attached to one of the three 10-ton cranes operating in this bay. The medium-sized castings are cleaned in the tumbling barrels at the south end of the east bay. Small, intricate castings are sand-blasted. Most of the other castings are cleaned by pneumatic chipping hammers. After the castings are cleaned, they are delivered to the grinding department, which is equipped with several stand grinders, and a battery of nine wheels mounted on swinging frames. Each of these grinders is belted from a main shaft and through a countershaft to secure a predetermined speed which is never changed. When a wheel wears down below the limits prescribed for the particular machine on which it is being used, it is removed and placed on another machine whose speed is suited to the reduced diameter of the wheel.

From the grinders the castings are delivered to the inspectors who either pass them for shipment or mark the defects. The smaller castings, passed by the inspectors, are ready for shipment, and are thrown into large metal buckets, of from three to four tons capacity each. These buckets are conveyed to the north end of the bay, where, by means of an automatic tripping device, their contents are dumped to the shipping platform, or directly into railroad cars.

The pattern shop occupies the south end of a 50 x 300-foot, one-story building, located several hundred feet west of the main foundry building. The patterns are stored in the room north of the pattern shop. Brick fire walls separate the two parts of the building. In line with this building, and several hundred feet south, is a well-equipped carpenter shop, in which repairs to wooden flasks are made.

The space between the pattern shop, pattern storage and carpenter shop buildings, and the main part of the plant is used for storing flasks. The power house, in the northwest corner of the main building, is equipped with modern power generating machinery and air compressors. The stock yard at the north end of the property includes buildings for brick storage, and platforms for the raw materials used in the open-hearth furnace. Fig. 10 shows a view of the stock yard. The derrick is self-propelled, and the tracks are so arranged that it may serve any part of the yard. Small trucks are used on the west spur of the railroad siding to deliver materials to the charging platform of the open-hearth furnace.

One of the largest castings used in the construction of locomotives is the frame, which varies in weight from two to seven tons. Two frames are required for each locomotive, and, as a rule, the molds for at least two frames are made at the same time. Orders for frames usually are accompanied by orders for the wheel centers and other smaller castings.

The flasks for frame molds are of the built-up type, six or seven sections being required for the cope and for the drag. Each section is of heavy cast steel construction, the ends being machined to provide a firm bearing surface, where adjacent sections are bolted together. The outside surface is well supplied with rings and projections so that crane chains and hooks may be attached easily. In Figs. 2 and 3 the construction of the flasks is clearly shown.

FIG. 10—DERRICK HANDLING SCRAP IN THE STOCK YARD NORTH OF THE FOUNDRY BUILDINGS. ELECTRIC MAGNETS PLAY AN IMPORTANT PART IN THE OPERATION OF THIS PLANT

Molding the Drag

The drag is molded by first filling the flask about half full of molding sand, which is leveled with a board to a depth just sufficient to allow the pattern to lie flush with the parting line of the flask. After the surface of the sand has been leveled, the pattern is lowered and enough pressure is applied to secure an imprint

of the frame. The pattern then is raised, while the sand is leveled further, and when this operating has been completed, the pattern is lowered again and the sand is rammed. The cope is almost a solid, rectangular mass of sand, except for the openings for the gates and risers. Pneumatic rammers are used almost exclusively. After the cope is rammed, it is lifted off by crane and the pattern is drawn from the drag. Fig. 2 shows the mold as it appears just after the pattern has been removed. At the right, the cope is shown braced in an upright position to enable workmen to patch the gates and risers. It will be noted that there is an unusually large amount of sand between the inner faces of the mold and the sides of the drag. All of the corners are nailed and the bottom part of the drag and practically all of the cope are strongly reinforced with gaggers.

When the mold has been finished, it is closed and is conveyed to the mold-drying oven. It is customary to place two molds on each car and each part is separated from the other by 6-inch blocks, which provide space between the surfaces of the molds for the circulation of the heated air of the drying oven. Fig. 3 shows two frame molds as they appear after removal from the ovens. The molds are cast from a 20-ton, bottom-pour ladle handled by one of the 25-ton cranes.

After pouring, the mold is conveyed to the south end of the foundry, where it is shaken-out and delivered to the cleaning room. Fig. 4 shows a typical frame casting as it appears after shaking-out. It will be noted that there is a 12-inch head at the center of each vertical member of the frame, and that a filling piece has been cast at the bottom of each pedestal jaw. These pieces are cut off by acetylene torches.

Annealing and Straightening

After the acetylene torch operators have completed their work, the frame is touched up here and there by grinding wheels. When it has been completely freed of sand, and when sprues, head and other irregularities have been removed, the frame is carried to an annealing pit, where it is subjected to a slow, moderate heat. This pit is 40 feet long, 9 feet wide and about 8 feet deep. It will accommodate, at one time, four or five frames, eight or 10 wheel centers and a considerable number of bolsters, frames braces and other medium-sized castings. The frames are removed from the annealer by means of a Cutler-Hammer magnet attached to a 10-ton crane. Fig. 5 shows a frame for a New York Central Mikado locomotive being lifted from the pit.

The straightening of the frame is accomplished by means of a 500-ton hydraulic press. The frame is swung into place under the ram by cranes and the straightening is effected by placing blocks underneath the edges of the castings and applying pressure to the ram. Fig. 6 shows a 7-ton frame for an Erie Railroad Mallet locomotive being straightened under the press.

Fig. 1 shows the 20-ton, bottom-pour ladle, pouring a wheel center casting. The flasks in the foreground give a good idea of the construction of this equipment for the heavier type of castings. The projections and rings cast onto the sides of the flask enable the men on the floor to quickly attach crane chains and hooks. The provision of ample fastenings of this kind is carried out in every department. A visitor in the foundry cannot help but be surprised at the rapidity with which heavy, unwieldy objects are safely handled by cranes.

During the past few years steel foundries have been securing considerable work, from street railway lines which formerly was allotted to gray iron foundries or to forge shops. One of the most important orders for electric railway equipment has been given to the Ohio Steel Foundry Co. by the Interborough Rapid Transit Co., New York. This company requires a large number of side frames for subway cars. Fig. 7 shows a view of one of these frames. In the background is a double furnace, which has been built especially for annealing these frames to comply with the rigid specifications. The order also calls for machining the pedestal jaws. The Ohio Steel Foundry Co. is planning the construction of an addition to its plant, which will provide facilities for machining castings. Approximately $35,000 will be expended in equipping the plant. Coupler yokes, center bearings and various smaller castings also are being made for subway electric cars.

The Ohio Steel Foundry Co., organized in 1907, has enjoyed a rapid growth. At present the demands upon the Lima plant greatly exceed its ca-

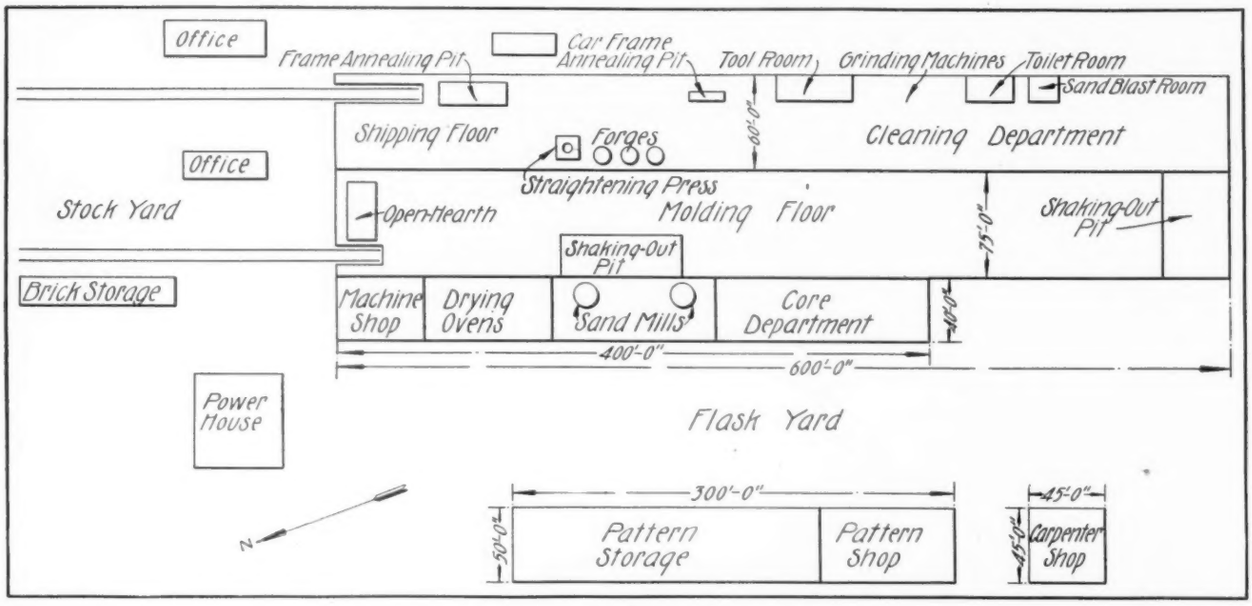


FIG. 11—PLAN OF THE OHIO STEEL CO.'S PLANT

pacity and recently the plant of the Carroll Foundry & Machine Co., Bucyrus, O., was purchased. After extensive alterations are made, this plant will have a capacity of about 800 tons of steel castings per month, relieving the congestion at Lima.

The officers of the Ohio Steel Foundry Co. follow: Harry Wright, president; J. E. Galvin, vice president, and John W. Kaufman, secretary and treasurer.

Can Molding Machines be Applied to My Work?

By Lewis R Palmer

OWING to the unusual activity prevailing in the foundry industry, managers and proprietors of casting plants are more interested in the application of molding machines to their work than ever before. Molding machines are as useful in dull times as in periods of great prosperity, in that they enable the machine foundry to take work profitable at prices which their competitors cannot meet, and in busy times they enable the founder to get the maximum production per foot of floor area and to handle a tonnage that will surprise those who are accustomed to having half of their shops filled with copes lifted off during the forenoon and bare after the molds are closed. These facts are appreciated by foundrymen engaged in specialty work whose shops are equipped with machines and, therefore, this article will be limited to the jobbing foundryman's problems and the writer hopes that it will help him to reap some of the benefits and profits made possible by the molding machine. In general, two classes of patterns are furnished to the jobbing foundry, namely, solid and split. The split patterns and flatbacks lend themselves most readily to machine molding. The solid pattern presents a more expensive proposition, but withal a simple one. The first consideration is the best type of machine for the large variety of work handled in jobbing foundry practice.

It has been the writer's experience that the plain jarring or bumping machine can be adapted to this class of work to excellent advantage. The plain bumper requires somewhat less rigging than some of the combination machines. After the type of machine has been decided upon, its location in the shop is a problem upon which a great deal of thought can be expended profitably.

Place the machine near enough to a wall or column that a jib crane can work over it and always underneath the traveling crane. Provide space for a large sand heap, or better yet, have a sand bin close to the machine. This will save time in filling the flasks. Also have room to lay out several flasks to be filled before placing them on the machine as this adds to its efficiency.

The following method of mounting split or flatback patterns for small orders will show a remarkable increase in production. Cross-lay two plain pattern boards with 1½ x 3-inch hard wood strips, joining the ends to cast iron end pieces, as shown in Fig. 1. The end pieces should be finished and drilled by the use of the same jig from which the flasks are drilled. This makes the rigging interchangeable. It also is advisable to insert, into the sides of the board where the flask rests, metal strips to prevent the flask from cutting into the board, thereby making a rough, uneven joint.

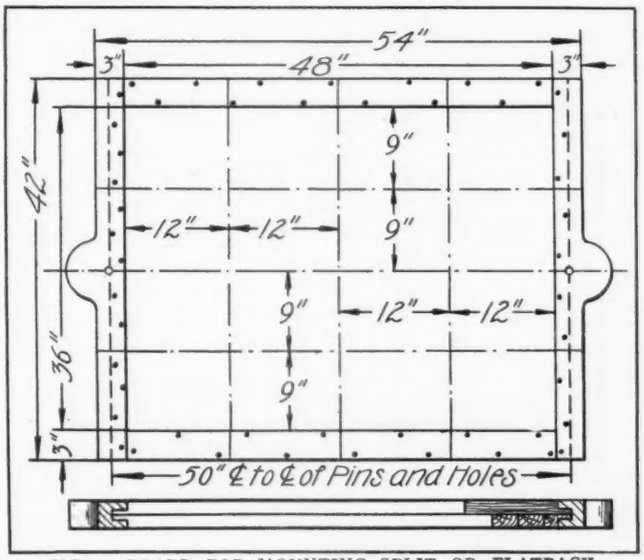


FIG. 1—BOARD FOR MOUNTING SPLIT OR FLATBACK PATTERN

Next lay out the center lines of the board for length and width. At the intersection of these lines, or in the center of the board, bore a ½-inch hole. Then at suitable distances along the center lines, say 6 or 12 inches, bore ½-inch holes, depending on the size of the board. It is good practice to insert metal plates into the board in which these holes are drilled as it prevents wear and consequent shifting.

To use these boards, take any split or flat bottom pattern, and lay it out square from the extreme edges, as shown in Fig. 2. Find the center and insert a 7/16-inch dowel pin. At the same distance from this dowel as the holes in the board, insert other dowel pins to give the correct position to the pattern. Ram the drag, and keeping the pattern in the same direction from the flask pins, reverse from one side to the other and ram the cope. The drag, when rolled over, will give a perfect match.

To adapt these pattern boards to roll-over and pattern-drawing machines, drill ¾-inch holes at suitable locations through which T-head wood screws can be inserted into the pattern and wedged tight to the back of the board. Three-inch battens will be needed on the pattern board in this case to keep the board from rocking on the machine. The irregular jointed, solid pattern presents a more difficult and expensive proposition, but it can be handled at a small cost, as follows: Make two forms of 1½-inch flask lumber to cover the flask joint and 3 inches deeper than the part of the pattern that is to extend into it. Attach pins and ears to interchange with the flasks. Ram a mold in the flask in the regular way, ramming the drag hard enough to withstand rolling over and lifting off. Then lift off the cope and turn it over onto a bottom board. Place the cope form over the drag flask or mold it with the pattern in place. Oil the pattern well and use plenty of good parting on the sand mold. Then ram-up a match of the following composition: One-half hardwood sawdust and one-half Portland cement. Fill the form slightly above the top to take care of shrinkage when dry and screw the bottom board on loosely. It can be drawn tight when the match has set.

Roll over the flask and match and lift off the drag. Scrape off any sand that adheres and finish with tools dipped in water. After the match has hardened, give it one or two coats of shellac. Repeat this with the cope after placing the patterns therein. These matches will last indefinitely and will effect a great saving in time, particularly on large,

deep work. Any particularly bad corners or draws can be protected by inserting blocks of wood studded with nails before ramming-up the match. In making these matches it is good practice to bar the form as well as to use plenty of nails, as shown in Fig. 3.

In making the composition, shake the sawdust through a fine sieve to remove the fine dirt, etc. Wet the cement sufficient only to mix it with the sawdust. It should have about the same consistency as molding sand for dry sand work.

To decide what sizes to adopt for standard flasks, group the work into classes and adopt a uniform depth of not less than 6 inches. Ten inches makes a good depth for both cope and drag. The flasks can be cast solid or build-up as preferred, and can be made with slides at suitable intervals into which loose bars can be wedged; or, they can be provided with holes and L-end bars bolted on. One of these flasks is shown in Fig. 4.

Efficient Machine Operation

To get the greatest possible efficiency from the machine requires much foresight and judgment on the part of the heads of all departments. Matches should be made several days before they are to be used. Flasks should be piled near the machine and special bars should be fitted to prevent delay in the operation of the machine. A rack for pattern boards near the machine saves time. The foreman should be provided with a good planning system and a clerk to look after the many details of the work of providing the rigging, leaving his mind free to look after the actual making of molds. It is advisable to have the machine gang and crane operator start work an hour before the molders. During this period sufficient drags can be made and placed on each floor to enable the molders to begin work when they arrive.

If each molding floor is given a number and the foreman selects the job for each and marks it on the pattern with chalk, the drag of that job can be rammed, bottom board clamped on, pattern board removed and the job placed on the proper floor for the molder to draw the pattern and finish promptly. The machine then can start ramming the copes for the jobs requiring them first.

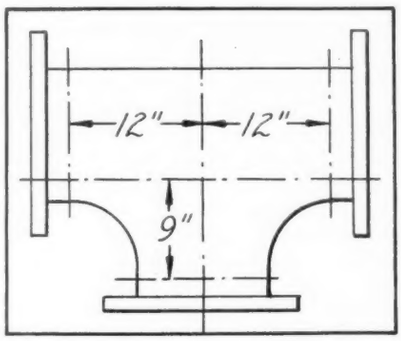


FIG. 2—METHOD OF LAYING OUT SPLIT OR FLATBACK PATTERN

This system will keep all hands working at high pressure and will show wonderful results, but it is always well to bear in mind that the personal equation is the force that makes or breaks its continuity and those contributing to its success should be rewarded in a substantial manner.

Sales of Rennerfelt Electric Furnaces

Sales of six additional Rennerfelt electric furnaces to manufacturers in this country are announced by Hamilton & Hansell, 17 Battery place, New York City. Several of these units are to manufacture ferro-tungsten, including one 2/3 ton, 150-kilowatt furnace sold to the Tungsten Products Co., Boulder, Colo., and two furnaces, one of the 3-ton and the other of 6 tons capacity, which have been contracted for by other companies, the names of which are not made public at this time. Other new installations of Rennerfelt furnaces include one 1/3 ton, 100-kilowatt furnace to the Gerline Brass Foundry Co., Kalamazoo, Mich., and a similar unit to the Titanium Alloy Mfg. Co., Niagara Falls, N. Y., both of which will be employed in the production of bronze. The Samson Iron Works, Stockton, Cal., also has purchased a ¾-ton, 225-kilowatt furnace for making steel. These new installations will make a total of 14 furnaces of the Rennerfelt type in the United States.

The plant of the Coleman Foundry Equipment Co., Cleveland, has been purchased by Julius Tuteur and the firm name has been changed to the Foundry Equipment Co. Mr. Tuteur has had a wide experience as a manufacturer, having been formerly president of the Columbian Hardware Co., the Duplex Hanger Co. and the Republic Structural Iron Works, of Cleveland. The company will specialize in equipment for gray iron, malleable, brass and steel foundries. The plant is located at 2102 to 2118 Abbey avenue.

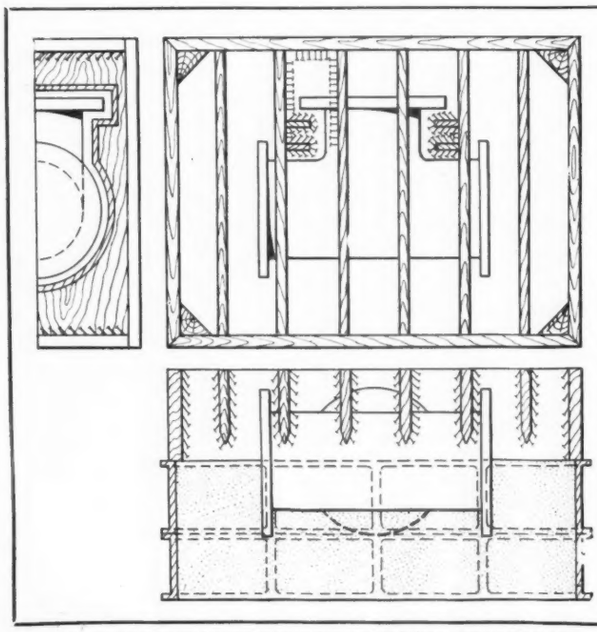


FIG. 3—HOW THE FORM FOR MATCHES IS BARRED AND NAILED

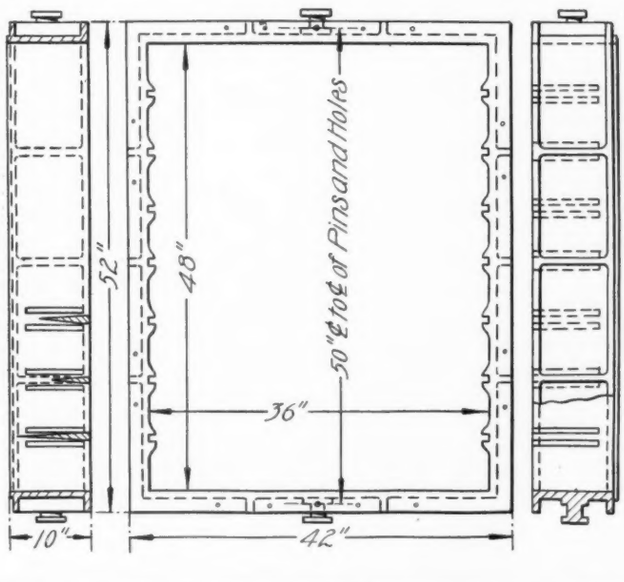


FIG. 4—DETAILS OF COPE FLASK. THE DRAG IS THE SAME AS THE COPE WITHOUT SLOTS FOR BARS

How Crude Oil is Used for Cupola Melting

The Cost of Fuel is Greatly Reduced, the Process Can Be Advantageously Controlled and Some Coke is Used in the Furnace

By Bradley Stoughton

THE OBJECT of the oil cupola process is to replace coke melting with oil melting. The cupola is chosen as the furnace because many years' experience have shown that this is the most efficient and cheapest known furnace for melting.

Three principles are essential to the success of this process: The first is preventing the iron in the cupola from matting together when it reaches the plastic stage which precedes melting. Cupola melting with oil or coke has been tried several times by merely filling the cupola with iron and then applying the flame at the lower part. In each case the result has been to entirely clog the cupola, because the iron, as soon as it becomes plastic, mats together by the weight of the metal above. It has been suggested that the cupola might be kept open and pervious to the heat by providing a bed of refractory metal in the lower part. Upon this bed the iron would rest. There are, however, two important objections to this: The first is that the melted iron-oxide and slag attack the fire brick and in time cause it to be joined together at the edges, making it impossible to dump the cupola and also making it impossible to use the same refractory material the second time, besides reducing the porosity of the bed. Those who are familiar with the cutting-out of the cupola lining at the melting zone will appreciate the difficulties that would be experienced with a bed of refractory material over which the melted iron oxide would flow.

The second difficulty of using fire brick to keep the charge open is that it would be necessary for the fire brick to be mixed with the iron in the upper part of the cupola. Otherwise, the matting together, instead of taking place at the melting zone, would take place at some point higher up. If, however, every charge of iron had to contain a certain proportion of refractory material, the result would be that the bed in the bottom of the cupola would be built-up to such a point that the iron would be raised above the melting zone.

It is possible that a bed consisting partly of fire brick and partly of a material which would be consumed might give more economical results than the bed now used in the oil cupolas, which consists entirely of coke.

Presented before the Pittsburgh Foundrymen's Association.

The second basic principle which it is necessary to recognize to secure success in oil melting is that crude oil cannot be efficiently burned unless some extraneous source of heat other than the combustion of the oil itself contributes to the flame. It is well known that an oil flame deposits graphite in large quantities, this graphite being due to the incomplete combustion of the oil. The use of preheated air is one means of supplying heat from an extraneous source and this results, in the open-hearth furnace, for example, in a great reduction of the amount of graphite deposited.

Coke Used for Bed

In the oil cupola, however, we are using a bed of coke and burning a very small amount of this bed in order to furnish that supplementary heat which is necessary to insure the complete combustion of the oil. The amount of bed which is burned is only a fraction of that burned in the ordinary coke melting process, since the heat for melting is obtained, in the oil cupola, chiefly from the combustion of oil. Merely enough coke is burned to maintain the bed in an incandescent state, and to supply a small amount of heat for promoting the complete combustion of the oil. This principle, which may seem unimportant and trivial, is of very great importance, and is essential to the success of the process.

By burning a very small amount of the bed, it makes it possible to mix a sufficient amount of coke with the charges of iron to maintain the shaft of the cupola in a porous condition and to prevent matting together of the material in that location. The coke used for this purpose ultimately finds its way down and replaces the coke burned from the bed.

The third principle upon which the success of the oil cupola process depends is the means for controlling the combustion of the oil and coke. We have discovered that, if air be mixed with atomized oil and blown upon a bed of red hot coke, the air will unite only with the oil, unless we supply more than enough air, when the additional air will burn the coke. In other words, the air unites by preference with the oil and will not burn any coke until there is an excess of air. This action is so well marked that one may direct a flame of burning oil upon a bed of red hot coke and actually put out the coke fire therewith, provided the oil flame does not contain an excess of air. The establishment of this principle enables one to absolutely control the combustion of the oil and coke by controling the amount of air admitted. It is possible to do this by admitting a regulated excess of air with the oil flame, but we prefer to maintain the oil and air in the flame in such proportions as will give complete combustion of the oil and then to burn the necessary small amount of coke by an independent admission of air.

For example, in the accompanying illustration, the oil and air are admitted through the pipes, *B* and *A* into the ignition chamber, *C*. The oil flame is started in this ignition chamber and enters the cupola in contact with the coke bed *F*. This coke bed is maintained in an incandescent state by an independent supply of air admitted through the tuyeres, *D*, which are underneath the ignition chambers, *C*. The peep holes at the end of the tuyeres, *D*, and the ignition chamber *C*, enable one to observe the combustion of oil and coke, and independent valves connected with each of the different pipes enables the air to be adjusted to give perfect combustion of oil in the ignition chamber and the necessary amount of combustion of the coke through the tuyeres *D*. It is obviously desirable to have the minimum possible consumption of coke which will maintain the bed in an incandescent state, and this is accomplished by adjusting the valves connected with the tuyeres, *D*.

The cupola is first filled with coke up to the melting zone and this coke is brought to a state of incandescence in the usual way. The amount of coke used and the method of getting it red hot is the same in the oil process as in the usual coke process. On top of the bed then is placed the first charge of iron, which also is the same size as in coke melting; then comes a layer of coke which is only one-quarter the amount ordinarily used. On top of this comes another layer of iron of the usual weight, then a layer of coke of one-quarter the usual size, etc. The coke bed is kept red hot at all times by its own combustion, but that combustion is very much less than the coke combustion in the ordinary cupola, because we do not want that heat to melt the iron; we merely want sufficient heat

to maintain the bed at a bright red color. In practice, we find that the amount of coke burned is generally one-quarter of the amount generally burned by the ordinary process and, therefore, the layers of coke coming down from above are just sufficient to replenish this bed and maintain it as in the ordinary cupola process.

The oil is atomized into ignition chambers surrounding the cupola, and is there mixed with air for its combustion. The flame from the burning oil enters the cupola and comes in contact with the bed of coke by which its combustion is hastened and completed. The result is an intensely hot oil flame by which the bulk of the melting is done.

The operation is similar to the ordinary coke melting operation, the principle difference being that the temperature is under better control by means of controling the oil and air admitted. When once adjusted, the oil flames need very little further attention.

At a plant near Philadelphia, which has been operating more than a year, it is found that the practical operation and regulation of the oil cupola is simpler and easier than the ordinary coke cupola.

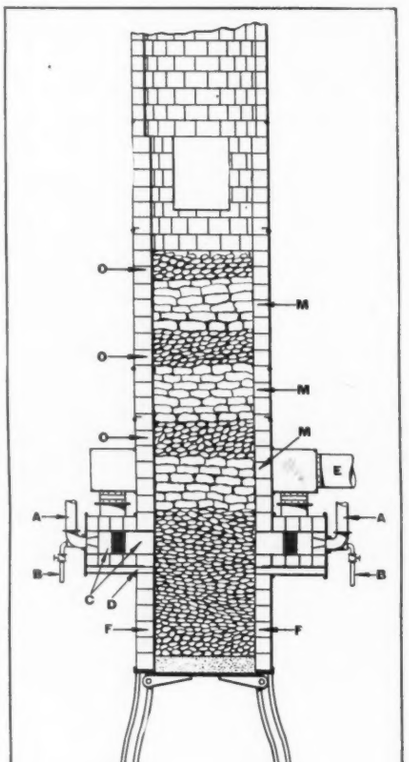
A plant in San Francisco was started in the middle of October, 1915, but it was impossible for any one who had had previous experience, or who had even seen an oil cupola, to be present when this cupola was lighted. The result was that it was started very cautiously, using a large amount of coke above the bed at first and gradually reducing it until somewhat more than three-quarters of the coke had been replaced with oil.

Results Obtained

In the cupola near Philadelphia which has been operating since March 14, 1915, it has been found that good, hot iron may be obtained with the expenditure of 60 pounds of coke and 7¼ gallons of oil to the ton of iron melted. This iron is hot enough for all foundry purposes, but may be made much hotter if desired by the use of a small, increased amount of oil. From the cupola in San Francisco, satisfactory iron has been obtained with 50 pounds of coke and 6 gallons of oil per ton of iron melted, but a more satisfactory result is obtained by the use of 65 pounds of coke and 6 gallons of oil per ton of iron melted.

When the process was first devised, the object was to save in the cost of fuel by replacing coke with oil; but a few months' experience has shown us, that although this saving in the price of fuel is very important in many places, of far greater advantage is the saving in the amount of sulphur absorbed by the iron.

The writer has made a study of sulphur absorption in the ordinary cupola process. In the year 1898 an extensive test was made on a number of cupolas during a week's operation. This test involved the making of many hundred analyses and showed a variable absorption of sulphur by the iron with about a total average for all cupolas for the week of 0.025 per cent of sulphur added to the metal during the melting process. In other words, iron which contained before melting 0.055 per cent sulphur would contain, after melting, 0.080 per cent sulphur. The coke used in this



CROSS-SECTION OF THE OIL-FIRED CUPOLA

A.—Air for atomizing oil.
B.—Oil-supply pipe.
C.—Ignition chamber.
D.—Tuyere for admitting air for combustion of coke.
E.—Main blast pipe.
F.—Coke bed.
M.—Charges of iron for melting.
O.—Supplementary coke charges.

test was a very good grade of Connellsville fuel containing a maximum of 0.50 per cent sulphur. The melting ratio was 1 to 10, including the bed, and limestone was used. The manganese was 0.50 per cent. The writer has heard of better results than this having been obtained, where the coke was chosen with great care and where constant watchfulness maintained the coke ratio at the lowest possible point. We have even been informed of practice for several days at a time showing a sulphur absorption less than 0.020 per cent sulphur, high manganese iron being used. At the present time, however, when the best Connellsville coke has been exhausted, and when the sulphur in coke is generally much higher than 0.50 per cent, it is not at all unusual for iron to absorb as much as 0.035 per cent, and in many cases 0.050 per cent of sulphur. All the previous examples refer to ordinary coke cupolas.

In our early experiments with the oil cupola, tests showed sulphur absorption of 0.012 per cent. A test recently made at a foundry near Philadelphia showed an absorption of 0.009 per cent sulphur, and a test made for us by Dr. Richard Moldenke showed absorption of 0.208 per cent.

The coke used in each of these last two tests contained 0.76 per cent sulphur; the oil contained 0.60 per cent sulphur, and the cupola slag in one of the tests contained 0.31 per cent sulphur. Limestone was used but the manganese in the iron was under 0.20 per cent. Before many months we hope to have a cupola in operation using natural gas as fuel instead of oil.

A Strong Iron

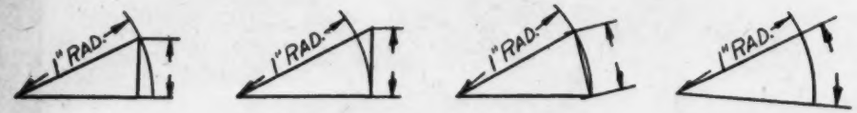
By W. J. Keep

Question:—Will you kindly furnish us with a gray iron mixture having a tensile strength of 30,000 pounds per square inch?

Answer:—This a problem that you will have to work out largely by experiment. Much depends upon the size of the casting, the strongest iron being that which has the closest gray grain. By adding steel scrap in the cupola or air furnace you will get the strongest castings. Such metal poured into a 1-inch square test bar would have a strength even greater than that which you mention. As a rule, it is safe to make a mixture of pig iron, No. 3 and No. 4 grade, of even, close grain, to which should be added just enough No. 1 or No. 2 pig iron to make it machine well. Also, the silicon should be kept as low as possible. Furthermore, the strong combinations of different brands of iron can be found experimentally. You might combine No. 3 and No. 4 grades and obtain quite a strong iron of a certain composition and use other No. 3 and No. 4 grades of the same analysis which would be weaker or stronger, or vice versa. By records of tests you can find exceptional mixtures for which there is apparently no explainable reason. Strength depends largely upon the knitting together of the grains, which property is purely physical. From the standpoint of the chemist low silicon, phosphorus and sulphur will give strong castings. Starting with this, try out the irons in your market and you undoubtedly

TABLE OF SINES, TANGENTS, CHORDS AND CIRCULAR ARCS.

By Arthur McAlpine



SINE TANGENT CHORD CIRCULAR ARC

DEG.	FOR 1-INCH RADIUS.	FOR 1-INCH RADIUS.	FOR 1-INCH RADIUS.	FOR 1-INCH RADIUS.
1	.0175	.0175	.0175	.0175
2	.0349	.0349	.0349	.0349
3	.0523	.0524	.0524	.0524
4	.0698	.0699	.0698	.0698
5	.0872	.0875	.0872	.0873
6	.1045	.1051	.1047	.1047
7	.1219	.1228	.1221	.1222
8	.1392	.1405	.1395	.1396
9	.1564	.1584	.1569	.1571
10	.1737	.1763	.1743	.1745
11	.1908	.1944	.1917	.1920
12	.2079	.2126	.2091	.2094
13	.2250	.2309	.2264	.2269
14	.2419	.2493	.2437	.2443
15	.2588	.2680	.2611	.2618
16	.2756	.2868	.2783	.2793
17	.2924	.3057	.2956	.2967
18	.3090	.3249	.3129	.3142
19	.3256	.3443	.3301	.3316
20	.3420	.3640	.3473	.3491
21	.3584	.3839	.3645	.3665
22	.3746	.4040	.3816	.3840
23	.3907	.4245	.3987	.4014
24	.4067	.4452	.4158	.4189
25	.4226	.4663	.4329	.4363
26	.4384	.4877	.4499	.4538
27	.4540	.5095	.4669	.4712
28	.4695	.5317	.4838	.4887
29	.4848	.5543	.5008	.5061
30	.5000	.5774	.5176	.5236
31	.5150	.6009	.5345	.5411
32	.5299	.6249	.5513	.5585
33	.5446	.6494	.5680	.5760
34	.5592	.6745	.5847	.5934
35	.5736	.7002	.6014	.6109
36	.5878	.7265	.6180	.6283
37	.6018	.7536	.6346	.6458
38	.6157	.7813	.6511	.6632
39	.6293	.8098	.6676	.6807
40	.6428	.8391	.6840	.6981

(Continued on Data Sheet No. 216.)

TABLE OF SINES, TANGENTS, CHORDS AND CIRCULAR ARCS.

By Arthur McAlpine

(Continued from Data Sheet No. 215.)

41	.6561	.8693	.7004	.7156
42	.6691	.9004	.7167	.7330
43	.6820	.9325	.7330	.7505
44	.6947	.9657	.7492	.7679
45	.7071	1.0000	.7654	.7854
46	.7193	1.0355	.7815	.8029
47	.7314	1.0724	.7975	.8203
48	.7431	1.1106	.8135	.8378
49	.7547	1.1504	.8294	.8552
50	.7660	1.1918	.8452	.8727
51	.7772	1.2349	.8610	.8901
52	.7880	1.2799	.8767	.9076
53	.7986	1.3270	.8924	.9250
54	.8090	1.3764	.9080	.9425
55	.8192	1.4282	.9235	.9599
56	.8290	1.4826	.9389	.9774
57	.8387	1.5399	.9543	.9948
58	.8481	1.6003	.9696	1.0123
59	.8572	1.6643	.9848	1.0297
60	.8660	1.7321	1.0000	1.0472
61	.8746	1.8041	1.0151	1.0647
62	.8830	1.8807	1.0301	1.0821
63	.8910	1.9626	1.0450	1.0996
64	.8988	2.0503	1.0598	1.1170
65	.9063	2.1445	1.0746	1.1345
66	.9136	2.2460	1.0893	1.1519
67	.9205	2.3559	1.1039	1.1694
68	.9272	2.4751	1.1184	1.1868
69	.9336	2.6051	1.1328	1.2043
70	.9397	2.7475	1.1472	1.2217
71	.9455	2.9042	1.1614	1.2392
72	.9511	3.0777	1.1756	1.2566
73	.9563	3.2709	1.1896	1.2741
74	.9613	3.4874	1.2036	1.2915
75	.9659	3.7321	1.2175	1.3090
76	.9703	4.0108	1.2313	1.3265
77	.9744	4.3315	1.2450	1.3439
78	.9782	4.7046	1.2586	1.3614
79	.9816	5.1446	1.2722	1.3788
80	.9848	5.6713	1.2856	1.3963
81	.9877	6.3138	1.2989	1.4137
82	.9903	7.1154	1.3121	1.4312
83	.9926	8.1444	1.3252	1.4486
84	.9945	9.5144	1.3383	1.4661
85	.9962	11.4301	1.3512	1.4835
86	.9976	14.3007	1.3640	1.5010
87	.9986	19.0811	1.3767	1.5184
88	.9994	28.6363	1.3893	1.5359
89	.9999	57.2900	1.4018	1.5533
90	1.0000	.....	1.4142	1.5708

THE FOUNDRY DATA SHEET, AUGUST, 1916

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

will be able to make a mixture which will give stronger castings than those you have made in the past. However, remember that with the same mixture the smaller casting will be stronger per square inch than a larger casting on account of the influence of the slower cooling of the larger casting, which makes the grain open and coarse.

Skilley Cores for Cast Iron Pipe

A new method of making cores for cast iron pipe, doing away entirely with the baking operation, has been developed recently at the plant of the American Cast Iron Pipe Co., Birmingham, Ala. Since time immemorial pipe cores have been made in a certain definite manner inherited from England. According to this system hay or excelsior rope is wound on a bar or mandrel and covered with a wet clay mixture, the core being revolved against a straight edge to produce a true cylindrical shape. The wet core must be baked in an oven for several hours before it is ready for use. This operation consumes time, labor and fuel. The new method makes it possible to use the same core bar four or five times a day, appreciably reducing the number of bars necessary to turn out a given tonnage of pipe. The cores are made by covering the bars with a special mixture called skilley.

Skilley is a pasty combination of clay, sand, paper, hair, molasses and cow manure. The latter is the principal ingredient. The constituents are mixed with water in an ordinary mud mill and when ready for use the skilley has the consistency of thick soup.

The core bars are drawn hot from the molds and are covered with skilley immediately, before they have time to cool. The skilley is simply thrown on the revolving bar, no straight-edge being used. The material is sufficiently thin so that the centrifugal force causes it to set in a true cylindrical form. Just the proper amount is supplied to produce a core of requisite diameter. As the core bar is revolved the heat in the bar itself is sufficient to dry the skilley. The result is a finished core, ready to go back into the mold. The cores are made over a tank in which the excess skilley is collected. It has been found that this method is best adapted to making cores for the larger sizes of pipe, 8 inches or over.

The value of natural abrasives produced and marketed in the United States during 1915 was $1,662,055.

According to figures compiled by the United States geological survey, 4,718 short tons of natural graphite, valued at $429,631, was sold in this country during 1915.

Computing Shrinkages for Patterns

By H. N. Tuttle

While it is the customary practice for the patternmaker to use a shrinkage rule in making the general run of patterns, to obtain the proper dimensions to secure the desired shrinkage, it frequently happens that he is called upon to make patterns for a part required to meet some unusual condition to which no shrinkage rule will apply. This may occur when the casting is to be made of some uncommon metal, or when extreme accuracy of the casting is required, or in the case of compound shrinkage, such as for a wood master pattern for an aluminum pattern for a steel casting.

To convert the casting dimensions to the proper pattern sizes, either of two methods may be employed and the diagrammatic method will be briefly described. A line, *AC*, Fig. 1, is drawn with a perpendicular line *BD*, making the distance, *AB*, 12 inches. The desired shrinkage per foot is indicated by *BC*, which will be assumed to be 0.4 inch. With dividers central at *A* and with the radius *AC*, or 12.4 inches, the arc, *CD*, is drawn intersecting *BD* at *D*. The diagonal line, *AD*, then is drawn, which, of course, is 12.4 inches long. Any distance measured upon the base line, *AC*, if erected to the upper line, *AD*, will have the desired shrinkage allowance of 0.4 inch per foot. For instance, if *AC* equals a 6-inch standard, then *AF* equals the 6.2-inch standard, or the 6-inch x 0.4-inch shrinkage rule.

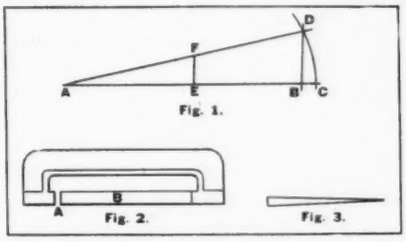


FIG. 1—DIAGRAMMATIC METHOD OF FIGURING PATTERN SHRINKAGE ALLOWANCE; FIG. 2—TEST GAGE FOR OBTAINING SHRINKAGE WITH A TEST BAR AND FIG. 3 IS THE WEDGE TO BE INSERTED AT *A*, FIG. 2

Mathematical Method

The mathematical method frequently is more convenient and is just as accurate as this. It consists of finding the proper factor or constant by which to multiply the standard rule measurement to give the proper shrinkage rule dimensions upon the standard rule. If a shrinkage allowance of 0.4 inch per foot is desired, which is about the correct shrinkage to allow for the wood master pattern for an aluminum pattern for a steel casting, then 0.4 divided by 12 equals 0.0333+, which is the shrinkage per inch equivalent to 0.4 inch per foot. If any common rule dimensions be multiplied by 1.033+, the result will be the dimension used in making the pattern by the standard or a common rule. For instance, 1.033+ × 6 inches equals 6.198+, or practically 6.2, which will give the proper shrinkage allowance. The mathematical method is of special convenience in obtaining the shrinkage in large patterns and for gears and sprockets.

Patterns for cast gears usually are made so that the tooth profile may be laid out from certain proportions of the circular pitch and the pitch diameters. It will be only necessary to multiply the circular pitch by the desired shrinkage factor and thereafter to use it instead of the standard circular pitch in all of the succeeding operations, the result each time giving the proper pattern size directly upon the standard rule and this without further trouble than that of increasing the circular pitch to the circular pitch, plus the shrinkage for the same. Herewith are given factors for a few of the common shrinkages:

5/32 in. + 1/4 for aluminum and steel shrinkage	= 1.0333
1/10 for iron	= 1.0083
1/8 + 1/10 for brass and iron	= 1.024
1/8 for brass	= 1.0156
1/4 for steel	= 1.021
5/32 + 1/10 for aluminum and iron	= 1.0213
5/32 for aluminum	= 1.013

It will be found much more convenient to use a standard rule divided into 50ths so that the decimal reading may be used directly. When there is any doubt about the shrinkage desired, it is advisable to make a test bar and to measure it carefully before deciding upon the allowance to be employed. The well-known method of running up the test bar between the seats of C-gage, leaving the gage in the sand until after the casting is chilled, is illustrated in Fig. 2. A wedge, Fig. 3, then is inserted between one end of the gage and the test casting to measure the shrinkage, which generally is considered to be the best method of obtaining accurate results.

The plant of T. P. Kelly & Co., Inc., located at Eighteenth place and Sangamon street, Chicago, was destroyed by fire Sunday, July 16. However, this caused the company only temporary embarrassment since a new warehouse with large facilities already has been obtained and a big stock of foundry supplies and equipment already is on hand to meet the requirements of the Kelly company's western trade.

During 1915 the United States' production of silica, in various forms, amounted to 243,340 short tons valued at $1,270,835.

How Sharp Buyers Work the Casting Market

A Discussion of the Senseless Competition That Prevails in the Foundry Industry Due to a Lack of a Knowledge of Costs

By W L Churchill

WHY ARE foundries such notoriously bad commercial risks The business mortalities, especially among jobbing foundries, are so numerous as to rank the line as extra hazardous from the banking standpoint. Most foundrymen explain competition as the chief cause, this in turn being due to the desire of certain foundries to get all the business in sight, and in their efforts in this direction, quote prices that are ruinous to whoever gets the work.

There are many foundrymen who regard other members of their fraternity with a great deal of animosity due to supposed unfair business methods and cut-throat tactics in securing business. The tendency to get together in associations is clearing away some of this misunderstanding and is changing the attitude of suspicion of the honesty of competitors' business methods to the conviction that ignorance of costs is at the bottom of most of the misunderstandings and that unfair competition is simply unintelligent competition.

Lack of Knowledge of Costs

Government investigations into the causes of the alarming and growing business mortalities generally attributes *lack of knowledge of costs* as one of the chief factors. It is beginning to be understood that if everyone knew exactly what each of his products cost to manufacture and sell, that prices generally would be fixed with more intelligence and that many manufacturers would discover the futility of attempting to manufacture certain of the lines that they do in competition with other specialists more advantageously situated.

This is especially true of foundries and more especially so of those of the jobbing type. Much has been written and a great deal of progress has been made in educating foundrymen to know their costs, yet few concerns have really reached a point where their foundry costs are so determined as to be an absolutely safe guide in the conduct of their business. There are probably as many foundries successful on account of good fortune in securing a line that is naturally profitable as from the exercise of special intelligence in quoting prices.

Many manufacturers who operate foundries as one of their producing departments, and who do not take in outside work are making just as serious errors in computing the costs of their finished product as the jobbing foundries. Many a manufacturer who includes foundry operations in his activities has been led far astray in fixing his selling prices by faulty figures on his foundry costs. There are many instances where these errors have been and are serious in causing goods to be put on the market at too low a price and in preventing the sale of other goods whose costs figure higher than is actually the case. Not only does all this apply to concerns that have given little or no consideration or effort to apply cost methods, but is equally true of many concerns with elaborate and expensively operated cost systems.

The foundry offers certain problems in cost accounting that are too little understood and many systems, designed to ascertain foundry costs, fail to grasp certain fundamental principles in foundry operations with the result that their conclusions are liable to be as far from the truth as the rough and ready guess of a competitor who has no such elaborate records.

Many such systems are operated for years without ever discovering their erroneous conclusions and only by some radical change in the character or volume of certain of the products of the plant is the matter brought to the attention of the management. Frequently, such a system is credited with being the last word in up to-date foundry methods, when in reality it is merely an expensive method of collecting records of certain direct and obvious facts and entirely unsuited as a guide to fixing selling prices.

Shrewd Buyers Work the Market

Sharp buyers of castings are able to take advantage of the existing conditions in fixing prices and get the foundry output for much less than it would be possible for them to produce the work themselves.

As illustrating this point one large manufacturer of agricultural machinery regularly places yearly contracts for castings at a flat rate per pound without guaranteeing to have all castings made at a single foundry. Of course bidders quote on what they consider will be an average cost to them and ask perhaps 4 cents a pound. This manufacturer has been making new lines every year for 20 years or more, and sells a great many repair and replacement parts for machines that are no longer manufactured. The result is that the foundry that gets the contract has a continuous procession of single piece orders to fill from old, battered and broken patterns, generally costing more to put into condition to cast from than they get for the work. Then the manufacturer decides to get out a new model of some machine, makes up a fine set of patterns, jobs around and finds another foundry that will quote perhaps 3½ cents per pound on a big run of the new lot.

How it is Done

The new model displaces a large tonnage that the first foundryman expected to produce and he wakes up at the end of the year of unprofitable work, raises his price before he will renew contracts and thus automatically drives Mr. Manufacturer away. Meanwhile contractor No. 2 has been well pleased with his bargain and is perhaps induced to take over the patterns formerly handled by No. 1. Foundryman No. 1 having a feeling of resentment toward No. 2 carefully refrains from warning the latter of what to expect and naturally keeps quiet about the unprofitableness of the work, or even if he informs No. 1, the latter may be inclined to believe his brief success due to superior management and fails to be guided by the experience of No. 2.

In the course of time No. 2 has his eyes opened and the whole procedure is repeated and another foundryman is located who is eager to accept the work; thus this manufacturer has had his patterns with many foundrymen, few of whom have come out with a net profit.

It is not to be inferred that the manufacturer has deliberately sought to get his castings at less than their cost of production by the jobbing foundries, but he long ago discovered he could buy castings for less than he could make them, and believing that concerns devoted to the special

business of making castings were logically able to make them cheaper than he could, he has felt justified in continuing the practice. This is not a fanciful or isolated case, many smaller consumers experiencing equal facility in obtaining castings at less than their cost to produce by jobbing around until they locate some one who quotes a price based on faulty knowledge or entire lack of knowledge of what such castings will cost him to produce.

In non-ferrous metal castings, variations in quotations are more startling than in iron or steel, although the percentage of variation between high and low bids may not be as great. The smaller jobbing foundries are the chief victims of their own ignorance of costs as the losses on a single or few contracts are more vital to their existence than the same loss would be to a larger plant.

In one of our large western cities many jobbing foundries go out of business every year, the vast majority on account of losses sustained by quoting low prices due to ignorance of their costs of production. Quoting too low a price for castings is not the only fault accountable to lack of cost knowledge, as much prospective business is lost through too high quotations due to this same lack of full knowledge of cost facts.

Arbitrary Scale of Prices

A large malleable foundry doing considerable jobbing business in addition to supplying its manufacturing departments, had established an arbitrary scale of selling prices based on a crude classification of patterns ranging from 3 to 6 cents a pound. The sales manager was chagrined to lose a large contract upon which he had quoted the minimum of 3 cents per pound. Believing that he could make these castings cheaper than his competitor, a thorough investigation was ordered into the methods of arriving at quotation prices, with the result that it was discovered that many patterns on which quotations of 5 and 6 cents per pound were being made were costing from 10 to 18 cents per pound; but still more serious, this foundry had been losing a lot of profitable business that could have been had at prices from 2 to 3 cents a pound. The executives of this foundry put themselves in position to quote intelligently on every pattern and rapidly changed the nature of their output as the castings more expensive to make rapidly drifted away to shops less thorough in determining their costs, and castings that could profitably be produced at the lower figures naturally gravitated to the shop that knew this and quoted accordingly.

Many manufacturers have been driven to the establishment of their own foundries when they would have preferred to buy their castings, but on account of the supposedly high prices charged, have decided to save the exorbitant profits paid to the jobbing shops. Usually, these supposedly high prices are due to the lack of knowledge on the part of the producers.

Basing Price on Weight

One of the most frequent indirect causes for faulty pricing is the almost universal habit of considering all foundry costs on the basis of weight of the completed casting. Outside of the cost of the material entering into the casting, there are only a few minor operations in foundry procedure whose costs parallel the weight of the completed parts. Even the cost of material entering into a completed casting of any given pattern is influenced by the total amount of metal used to produce the casting, and the consequent variation in amount of metal lost in making different castings. As a rough and ready means of comparing results, the cost per pound has a certain usefulness, but its chief excuse is its convenience to purchasers and shippers.

Many foundrymen have acquired a mental facility in estimating approximate value of any casting by a mere glance and applying a rude classification and quoting off-hand prices that they believe will cover their cost and profit, and not having any way to currently check all of these guesses (as they can be nothing else), soon believe they have a certain ability in this direction that is positively uncanny. Between plain or fancy guessing to more careful calculation based on a faulty costing plan there is little choice, either method can make for unaccountable losses or drive away prospective, profitable business.

The habit of quoting on a price-per-pound basis has the effect of mentally discouraging quotations outside of certain maximum and minimum figures that prices on a unit basis do not have. Undoubtedly, the habit will persist, its very convenience, even though illogical, will retain many adherents among both the buyers and producers.

Another common cause for faulty quotations is the habit of meeting the other fellow's figures, without regard to whether his figures were established intelligently or not. Many foundrymen assume that if some competitor can quote a certain figure he can quote as low or lower; on the other hand, if a competitor quotes a higher price, he immediately gets nervous and wonders whether he quoted too low.

The foundry that operates as a department of a manufacturing plant frequently establishes costs on a basis of outside quotations, leaving them open to all the fallacies of the typical jobbing foundry. The obvious cure for all of these troubles is a correct knowledge of costs, and by correct knowledge is not meant a collection of minute detail figures pertaining to each and every handling of a pattern and its resultant castings through a foundry, but a thorough knowledge of what factors influence costs, and to what extent they *will* affect any given pattern or casting.

So many of the factors that influence the cost of castings are impractical of direct collection into current cost accounting data that typical cost collecting systems fail to meet the requirements in many foundries having divergent products and conditions of production.

Where there is a reasonable degree of uniformity in classes of castings made and volume of output, or where the varied production is finally assembled into a complete unit, such methods generally serve their purpose very well, and although frequently criticized on the score of expense for operating, usually offer a satisfactory means for establishing selling prices.

Elusive Factors

The elusive factors that make it so difficult to establish proper prices for castings where considerable diversity in sizes of orders as well as in types of castings exist, follow:

First, the question of the number of castings to be made from a pattern or set of patterns offers opportunities for decided variations in cost under different conditions for the same casting. There is always a definite and substantial expense for preparation from the booking of the order and issuing the proper foundry instructions such as locating and examining stored patterns and core boxes; putting these and newer ones into condition for use; locating and supplying flasks, strippers, weights, bottomboards, making matches, cutting core wires and issuing instructions to molders and coremakers.

In foundries where frequent changes of patterns are required a sizeable and expensive organization is devoted continuously or intermittently to the duties necessary to placing patterns

in work. In one foundry, where this subject has been well investigated and which is confined to bench and smaller floor castings, it has been determined that the average cost, merely to start an order is over 80 cents for labor, and that the lowest cost at which an order can be started is 25 cents, while others cost as high as $2, exclusive of chargeable repairs and equipment expense.

Few foundries attempt to segregate these costs against individual patterns or orders, and with many nothing would be gained by so doing; yet with others, it is a factor that encourages more and more short run business, eventually forcing a higher general overhead on all castings, thus automatically driving away business that is not responsible for this increase in overhead.

Handling Unfamiliar Patterns

Another direction in which short orders enhance costs is due to the added time per unit required for molding and coremaking on unfamiliar patterns. Careful tests and observations conducted for the purpose of determining the influence of this factor on foundry costs, worked out in one shop, indicated that it requires 2½ days of continuous work on the simplest machine castings for the average molder to acquire his top speed of production, and in more difficult classes of castings, 3, 3½ or 4 days. It also was established that during the first hour such workmen produce less than 20 per cent of their maximum output, gradually increasing with added familiarity and proficiency. Some foundries attempt to collect this factor of cost, but it is generally ignored, or efforts are made either to conceal it or reduce it by forcing piecework molders to work on standard rates overcoming their loss by giving them other patterns carrying compensating advantages in piece prices.

The two factors of cost due to preparation and acquiring familiarity might be properly termed *order costs*, as they are controlable only to a slight degree by the pattern itself. The proportion of effect of these factors on total cost and consequent proper selling price varies with the number of pieces to be made. For a single or a small number of castings it is overwhelmingly large, while for continuous runs and for heavy castings is almost negligible.

The question of whether to segregate these expenses against individual orders or patterns, or simply to let them become a part of the general foundry expenses needs to be decided on a basis of their effects on each particular line of foundry work that may be under consideration; although technically correct, in many foundries the refinement of accuracy thus obtained would be unimportant, while with others, it may mean the difference between operating profitably or at a loss.

Another elusive factor in foundry costs that makes wide variations in cost per pound in different types of castings, and that rarely receives consideration in typical accounting methods, is the cost of melting the metal required to obtain the finished casting. The practice of treating the operation of melting as a distinct and separate process from molding is not as generally adopted as it should be, although here again the question of its importance needs to be considered in relation to the varieties and types of castings produced in any one foundry.

Few foundrymen realize what their melting costs are, and even when segregated ,seldom include all the factors that enter into the cost of the melting operation, and even when fuel, supplies and labor assigned to melting are separated, the items of depreciation, power, space occupied. supervision and metal losses by oxidation are apt to be overlooked or included in a general expense burden.

With foundries making widely divergent classes of castings, this factor can account for the mysterious disappearance of profits; in fact, in more than one instance it has been responsible for complete business failure, despite elaborate cost accounting records maintained, but which failed to segregate the cost of melting specifically against the different and dissimilar castings.

Considering the Remelt

Although a rather common practice is to consider the average remelt in arriving at casting costs and prices, it is seldom that the specific remelt necessary to individual castings is ascertained or considered in arriving at these figures. A foundry may be averaging 50 per cent remelt and may base all prices accordingly, yet some smaller and difficult castings may require several times their weight of metal to be melted to fill sprues, gates, risers and make up for misruns, while other heavier and simpler castings take not over 20 per cent extra metal to make. In addition to the variation in melting cost per pound of product due to the difference in the amount of molten metal required, the loss by oxidation caused by the melting operation parallels the total melt.

The more expensive the mixture the more important it is that this loss by oxidation be placed against each casting where there is a wide divergence in the proportion of remelt, but even with iron castings, failure to properly consider this factor often leads to faulty conclusions that in themselves tend gradually to change the character of the work done by encouraging business with heavy remelts, and driving away the simpler castings.

Although the direct operations of molding and coremaking usually receive close attention in figuring prices, it frequently happens that they are of lesser importance than the more direct costs previously mentioned, but even here many mistakes are made; in efforts to secure business, estimates for these operations are often made without due allowance for size of orders, proportion of losses, and even arbitrarily low and unjust piece rates often are made to force costs down to a point that will insure a profit at the price that some sharp buyer has indicated it to be necessary to meet to get the business. When the castings are being made, concessions in the form of day work, padding the count, or giving a fancy price on other patterns are resorted to to cover the actual costs and to make the figures agree with the estimate.

Cleaning Costs

In the subsequent finishing operations there also are opportunities for divergent costs per pound, such as in sprue cutting, chipping, tumbling, sorting, annealing, grinding, straightening, inspecting and shipping. In the average foundry few of these operations are considered on a cost per unit basis owing to difficulty of collecting reliable costs on current work of these operations. The general practice of placing all or nearly all such operations in a common average cost penalizes many of the simpler castings with a portion of the excessive costs for these operations on the more delicate, intricate and troublesome patterns.

The more complex questions of distribution of selling expenses and the proper apportionment of administration accounts against foundries, and in turn their proper application to orders or specific castings need to be considered with more care than is usually the case. The easiest way of disposing of these expenses by lumping them into one general account and apportioning them on a percentage of labor or total direct cost is not always equitable, and the larger these general expenses are in proportion to total costs, the greater the oppor-

tunity for faulty conclusions by using such methods.

When foundrymen take the same trouble to analyze their processes and the cost factors that enter into their business that they do in analyzing the chemical elements of their materials and products, then the fixing of prices will become a positive arithmetical calculation devoid of the present elements of chance.

The adoption of cost principles that puts foundries on a basis that enables such definite and complete knowledge of their costs need have no greater terrors than the adoption of the principle of buying metals and casting them on definite chemical analysis, instead of by fracture and guesswork.

Likewise, the adoption of such methods usually displaces much otherwise necessary or supposedly necessary clerical labor, just as operating a foundry on definite chemical formulas reduces unnecessary operating labor due to faulty castings.

One of the axioms in manufacturing methods is that the amount of red tape or system necessary in any business will parallel the value of its products. This seemingly holds true in foundry operations, since intelligently fixing prices requires less effort than now is devoted to supplying unsatisfactory and misleading figures.

Repairing a Run-Out in a Cupola

By W. J. Keep

Question:—Our cupola is lined to 62 inches, being provided with a slag spout. Recently the iron cut through this spout and flowed out in several streams. Would it be possible to plug up the cupola long enough to stop this break?

Answer:—When such an accident occurs, shut off the blast and leave the tap hole open to drain off all the molten iron. You can stop melting for half an hour and resume satisfactorily when the blast is again applied. No definite procedure customarily is followed when an accident of this kind occurs. When cutting through the slag spout, there is no reason why repairs cannot be made without checking the blast. Increasing the size of the tap hole would have the effect of immediately lowering the iron in the cupola so that it would not run out of the slag hole. The latter then could be stopped until repairs are made and you could finish the heat without draining off the slag, if necessary. While the slag should run constantly, yet it is frequently necessary to stop-up the slag hole, from time to time, to prevent the blast from blowing out. Also, you can dam the slag spout and let the slag run over the side while repairs are being made.

The Construction of a Small Cupola

By W. J. Keep

Question:—We are considering the construction of a cupola, 20 inches inside the lining and we would like to know what the distance should be from the bottom plate to the bottom of the charging door, number of tuyeres and size and the distance of the bottoms of the tuyeres to the bottom plate. How high above the tuyeres should the bed charge extend, what size fan should be employed and how many revolutions should it operate per minute? Also let us know how to make the charges of iron and coke and whether it is advisable to tap the slag, the location of the slag hole if necessary and the size of the blast pipes from the fan to the cupola.

Answer:—Unless you have had a wide experience in cupola management, it would be unwise to attempt the construction of so small a furnace. A cupola, except perhaps for experimental purposes, should be sufficiently large to enable a man to get inside of it to chip it out and to make repairs A furnace, 28 inches inside diameter, is as small as practical for this purpose. You can melt 500 pounds of iron in a cupola of this size just as well as in one that is considerably smaller. The time consumed by men standing around for enough iron to melt to fill three or four ladles will cost more than the economies which you intend to effect. I use a cupola consisting of sections, 18 inches high, with hooked handles on each side so that by placing two bars underneath these handles, two men can lift off one of these sections. In a cupola of this kind, lined to 16 inches, I have succeeded in melting 500 pounds of good iron. A cupola of this type, lined to 21 inches, also is used frequently for making heats from 1½ to 3 tons, but one of this size requires a hoist to lift off the sections. I have another cupola which is of the single shell type, 28 inches in diameter and which is sufficiently large to permit a man to get inside to make repairs. The bottoms of the tuyeres should be located about 12 inches above the sand bottom and approximately six tuyeres should be installed.

Inside of the lining, the tuyeres should be nearly continuous, the space between them not exceeding 4 inches. However, this space should be increased above the slag hole and its center should be 4 inches below the bottoms of the tuyeres. The height to the charging door can be arranged to suit your convenience, and for a cupola 28 inches in diameter it should be about 10 feet above the foundry floor. For a cupola 21 inches in diameter about 6 feet from the floor will be satisfactory. The iron charged in a small cupola should be broken proportionately small. In charging a 28-inch cupola the best results are obtained when the pigs are broken into 9-inch sections and the scrap should be the same size or smaller. The blast pressure should be about seven ounces. Heat the cupola for about two hours, when the coke bed should extend about 15 inches above the tops of the tuyeres. The iron charge should consist of about one layer of pigs covered by about 3 inches of scrap. You can figure on about one-tenth, by weight, of coke to iron for each charge. The wind belt should be of ample size with a door opposite each tuyere. One entrance for the blast will be satisfactory and for a cupola 28 inches in diameter an 8-inch blast pipe will be ample and a 6-inch blast pipe can be used for a cupola 21 inches in diameter.

Cast Iron for Electrical Machinery

By W. J. Keep

Question:—The mixture which I am using for electrical machinery castings contains silicon, 2.10 per cent; phosphorus, 0.75 per cent; sulphur, 0.051 per cent; manganese, 0.31 per cent; combined carbon, 0.50 per cent and graphitic carbon, 2.85 per cent. By continuous heating I have reduced the combined carbon of this iron, 0.18 per cent. Can I produce a metal approaching the quality of steel by making a semi-steel of the following analysis: Silicon, 1.80 per cent; sulphur, 0.095 per cent; phosphorus, 0.27 per cent; manganese, 0.20 per cent and total carbon, 1.40 per cent?

Answer:—The *Transactions* of the American Foundrymen's Association give the following analyses for cast iron for electrical purposes: Large dynamo frames—Silicon, 2 to 2.50 per cent; sulphur, 0.08 per cent; phosphorus, 0.50 to 0.80 per cent; manganese, 0.30 to 0.40 per cent; combined carbon, 0.20 to 0.30 per cent and total carbon, low. For small dynamo frames and miscellaneous electrical castings, the silicon is 2.50 to 3 per cent and 2 to 3 per cent respectively, and the sulphur is 0.08 and 0.07 per cent, respectively; the phosphorus, manganese, combined and total carbons are the same as for large dynamo frames. You will note that the most desirable iron is the softest with the lowest combined carbon. While the total carbon is to be low, it must be high enough to cause the major portion to be in a graphitic state. Therefore, it is evident that a semi-steel mixture is not what you require, since melting steel scrap with cast iron and changing the carbon to the combined state is the opposite of what you need. It is advisable to have an analysis of your castings made by a chemist. You cannot melt iron in a

cupola that will give you sulphur as low as 0.05 per cent and with the analysis you give, the combined carbon hardly would be 0.50 per cent. Annealing is an effective way to reduce the combined carbon, but it is somewhat expensive. There are too many complications in a foundry mixture to apply theories of magnetic permeability, and your castings will give satisfactory service if they are within the limits prescribed by the American Foundrymen's Association.

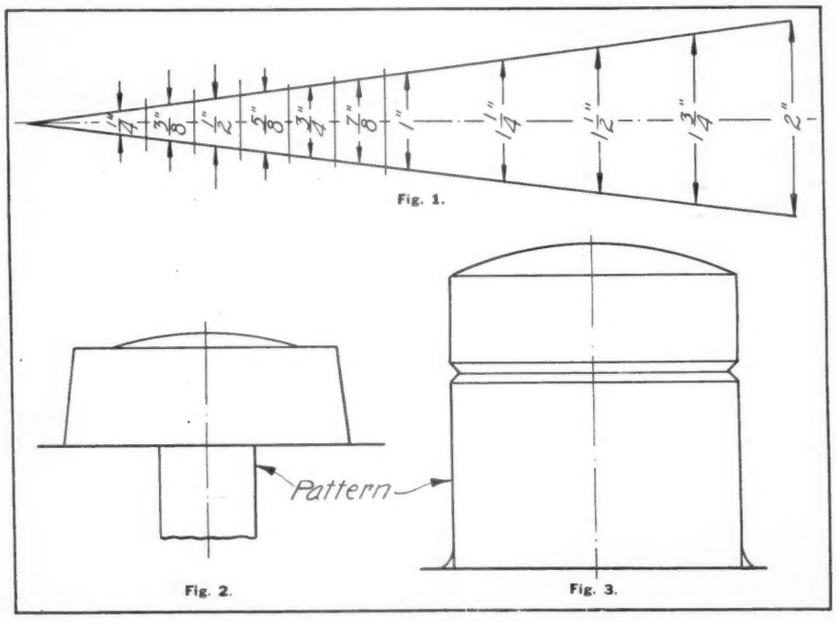
Lower Rates on Molding Sand

Foundrymen of Ohio are now benefiting from the successful efforts made by the Ohio Sand Traffic Association to secure a reduction in railroad rates on sand blast and molding sands. This association has been active in opposing the attempts of the railroads to increase by 15 per cent the rates on molding sand shipped in box cars. The railroads secured permission from the public utilities commission of Ohio to put this advance into effect, beginning April 1. As a result of the activities of the Ohio Sand Traffic Association, which was organized especially to secure relief from this discrimination, this advance was withdrawn, the old rates being in effect since June 20.

The association in appearing before the commission pointed out the unjust discrimination in advancing rates on box car shipments as compared with gondola shipments. Users of the higher grades of sand invariably receive their shipments in box cars, the commoner grades of sand moving in gondolas. As a result, the bulk of the advance fell on Ohio foundries. This advance related only to intrastate movement. As a result, in one instance a foundryman in Toledo was paying $1.21 on box car shipments against a rate of $1.16 to Detroit, which was 69 miles further.

The association was formed with the following members: Central Silica Co., Zanesville; Gordon Sand Co., Conneaut; Interstate Sand Co., Zanesville; H. A. Keener, Columbus; New Lexington Sand Co., New Lexington; Portage Silica Co., Youngstown; Standard Sand & Machine Co., Cleveland; Superior Sand Co., Cleveland; Summit Silica Co., Barberton, and National Sand & Stone Co., Niles. The association enlisted the services of the Lent Traffic Co., Pittsburgh.

The members of the association have decided to continue the organization with a view of promoting the interests of their industry.



SUGGESTIONS FOR STANDARD CORE PRINTS

Graphite Mining in the United States

Graphite mining in the south has been stimulated during the last year and a half by the shortage of Ceylon graphite and American manufacturers of crucibles, as well as foundry facings, have been compelled to resort to the use of the domestic product. The present centers of production are in Clay and Chilton counties, Alabama, and preparations are being made to exploit a promising graphite deposit near Burnet, Texas.

The Keller Pneumatic Tool Co., Fond du Lac, Wis., manufacturer of pneumatic tools, including chipping hammers, rammers, drills, etc., has established a sales office in Chicago at No. 10 South La Salle street.

Standardizing Core Prints

By F. W. Redshaw

Standardizing core prints is a subject which should have the earnest consideration of every foundryman, and I was glad to note the suggestions made in the articles recently published in THE FOUNDRY.

After considerable experience in endeavoring to devise a standard for core prints I have come to the conclusion that a desirable taper for vertical prints is 1 inch in 8 inches with the length equal to the diameter up to 1 inch, all vertical prints over 1 inch in diameter to have a length of 1 inch. The advantages of a standard taper of this kind are indicated in Fig. 1. A print, 1 inch in diameter and 1 inch long, would be ¾-inch in diameter at the top and a ½-inch print would be ⅜-inch, and a ⅝-inch print would be ⅛-inch at the top, etc. It is advisable to have cope and drag prints alike, and where the work is standard, a special core box provided with tapered ends for the prints should be made, as otherwise a core machine and grinder are necessary for accuracy.

Vertical core prints, 3 inches or more in diameter, should be made as indicated in Fig. 2, to insure the proper setting of the core in the drag. For horizontal prints it is desirable to have the length equal the diameter up to 3 inches, with the fillet or taper piece turned next to the pattern to avoid crushing. Also, a groove should be turned in the print at a point about two-thirds of its length from the pattern, as indicated in Fig. 3, to prevent the leakage of metal around the core. All such standards should be as simple as possible to prevent errors on the part of the molder.

Platinum in 1915

According to reports received by the United States geological survey from platinum refiners, 8,665 troy ounces of new metals of the platinum group were recovered of which at least 1,587 troy ounces are believed to be of domestic origin. Secondary metals derived from the refining of scrap and sweeps amounting to 42,970 troy ounces were sold in 1915.

Notwithstanding the embargo placed upon the exportation of platinum by the allied governments, the imports of platinum and allied metals during 1915 reached a total of over 69,000 ounces valued at $2,768,688, a falling off of only 10 per cent below the 1914 imports.

The Western Crucible Steel Castings, Minneapolis, Minn., has placed an order with the Snyder Electric Furnace Co., Chicago, for the installation of a furnace with a rated capacity of one ton.

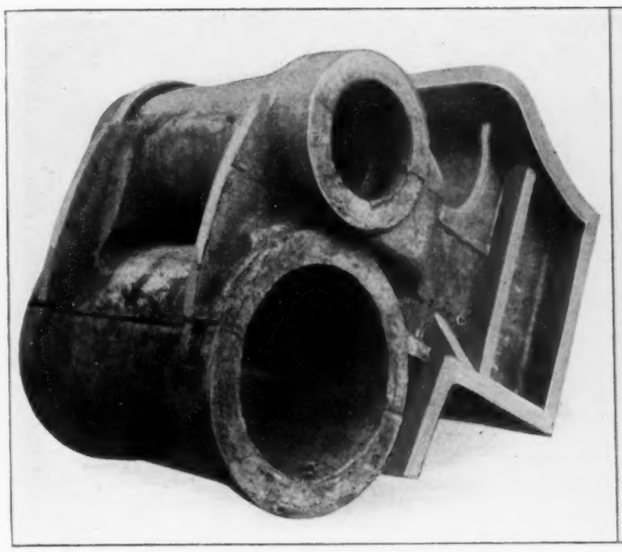


Fig. 1—Locomotive Piston Valve Cylinder Showing Cylinder and Piston Valve Chamber, Reinforcing Ribs and Saddle

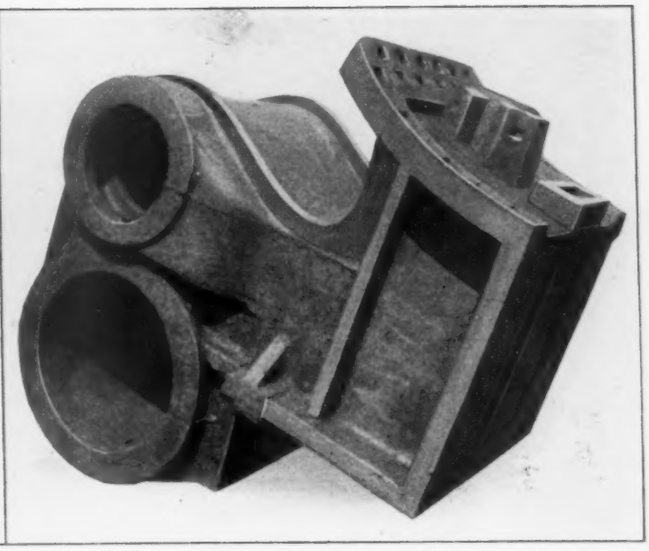


Fig. 2—Another View of Casting Showing Details of Saddle Including Exhause Pipe Seat and Steam Pipe Connection

Molding a Large Locomotive Cylinder

By B Rupert Hall

BECAUSE of its complex design, necessitating numerous cores, and demanding an unusual degree of accuracy, the piston valve type of locomotive cylinder requires the best efforts and most exacting skill of the foundryman engaged in this line of work. Assembling the mold, withdrawing the pattern, placing the cores, and the arrangement of gates and risers involves great care and ingenuity of the highest order. Fig. 1 illustrates a typical piston valve cylinder casting showing the cylinder and picton valve chamber, the reinforcing ribs and the outline of the saddle. Fig. 2 is another view of the same casting showing the saddle, the exhaust pipe seat, steam pipe connection, and flange for the bolt connection between the saddle and the boiler shell.

The pattern consists of three principal sections and a number of loose pieces, Fig. 3 showing the model assembled. Parts for the steam cylinder, the piston valve chamber and ports, and the saddle, form the three important sections of the pattern. The steam pipe connections, exhaust pipe seat, ribs, etc., require separate pieces which are fitted to the main pattern. Fig. 4 is a view of the pattern for the piston valve chamber and saddle, the pattern for the steam cylinder having been removed.

The arrangement of the pattern in the mold is shown in cross-section in

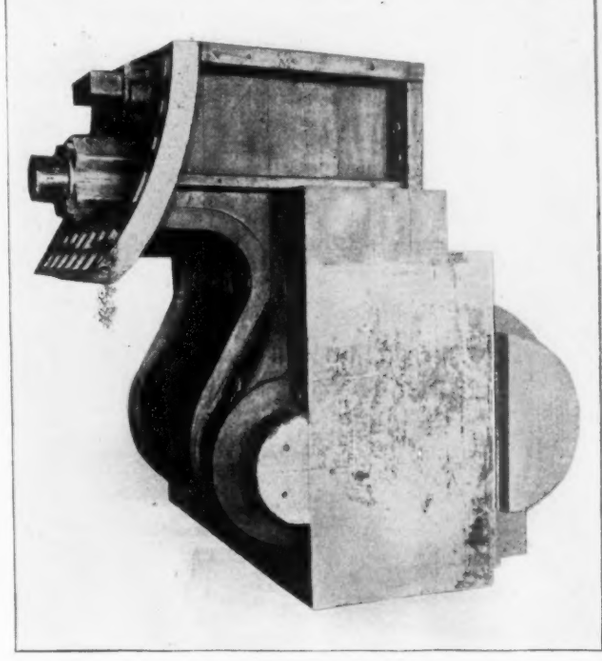


FIG. 3—ASSEMBLED PATTERN FOR PISTON VALVE CYLINDER CASTING

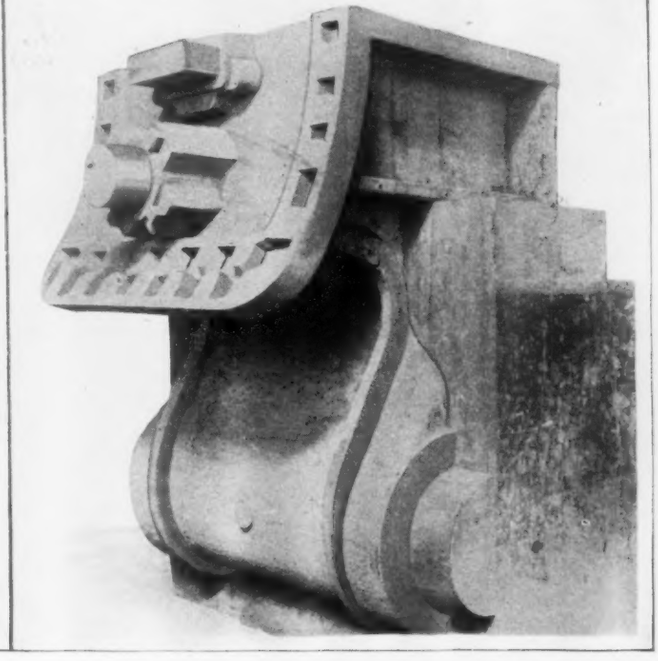


FIG. 4—PATTERN WITH CYLINDER PART REMOVED, SHOWING LOOSE PIECES IN SADDLE

FIG. 5—CORE FOR PART OF PISTON VALVE CHAMBER AND STEAM PIPE; FIG. 6—CORE FOR EXHAUST PIPE; FIG. 7—PISTON VALVE CHAMBER CORE ON DRYING PLATE; FIG. 8—SWEEP AND HALF-CORE FOR STEAM CYLINDER; FIG. 9—EXHAUST PIPE CORE BOX

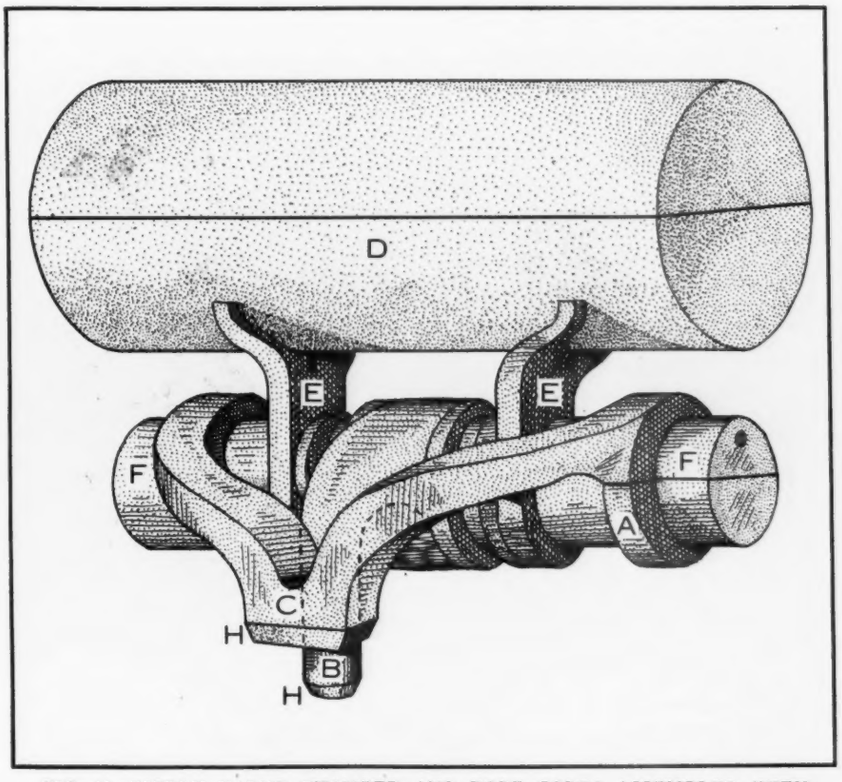


FIG. 10—PISTON VALVE CHAMBER AND PORT CORES ASSEMBLED WITH THE CYLINDER CORE

Fig. 11. The flask is made of cast iron channel plates assembled and bolted together in such a way that single plates may be removed without disturbing the mold. The mold is divided at the lines *ab* and *cd*, *abcd* forming the flask *cdef* the drag and *abgh* the cope.

In building the mold, the main section of the pattern, which forms the piston valve chamber and the ports, is placed in the flask. Its position is shown in Fig. 11, except that both flask and pattern are inverted, the line *cd* being at the top. After the sand is carefully rammed to the top of the flask, the pattern of the saddle is placed in position, and the drag bolted to the flask. Sand is tucked under the saddle until the parting line *clmn* is formed for the drag. The loose patterns for the exhaust and live steam pipe connections, shown at *A* and *B* are put in place, and the sand rammed up to the level of the top.

Making the Mold

The flask is rolled over, taking the position shown in Fig. 11. A support, *C*, is placed under the corner of the mold to help sustain the weight of the overhanging part. The pattern for the steam cylinder is set on the main part of the pattern, and the cope set in place on the line *ab*. The sand in the space *ajki* is removed and a parting made to extend the cope surface down into the flask.

After the cope is filled and rammed, the mold is separated and the pattern removed. The cope is lifted first. The side plate of the flask, shown at *D*, is removed to permit of removing the main part of the pattern from the mold. The loose pieces, *E* and *F*, are easily taken out, after which the saddle pattern is removed. The small pieces, *A* and *B*, are then picked out, freeing the pattern from the mold which is then ready for the drying oven.

Fig. 10 shows the four principal cores assembled; *A* is the piston valve chamber core; *B*, the live steam pipe core with the attached parts, *EE*, for the ports; *C* is the exhaust pipe core and *D* is the core for the steam cylinder. The lower ends of the steam and exhaust pipe cores have prints *HH*, which are anchored in the bottom of the drag, as shown in Fig. 11.

Setting the Cores

The core for the upper part of the valve chamber, shown in Fig. 7, is first lowered into place in the mold. To give an unobstructed entrance for the cores, channel plates are removed from the front of the mold. The live steam pipe core, with ports, shown in Fig. 5, is next placed in position. The exhaust pipe core, Fig. 6, is made in the heavy core box shown in Fig. 9. The loose piece at the top forms an opening to receive the extension core for the exhaust pipe seat.

The core for the cylinder barrel is swept-up in halves on a cast iron grid, shown in Fig. 8. The core is held in place by the ends of the grid which rest in the sides of the flask. The grid has a surface of thin projections which help to support the sand. The form for the core consists of two semi-circular discs attached to two, 2 x 4-inch

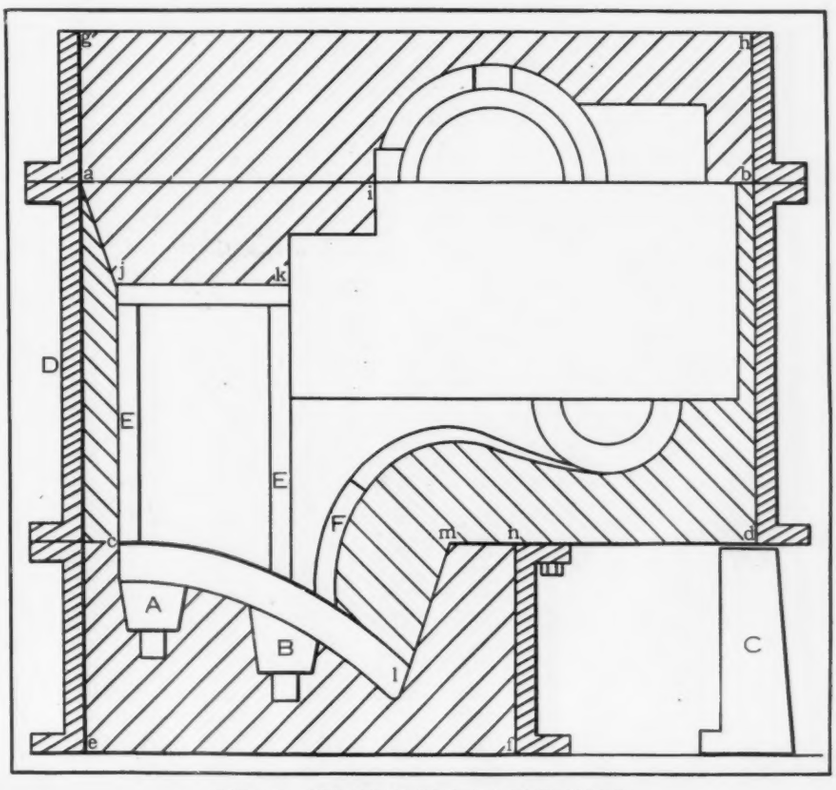
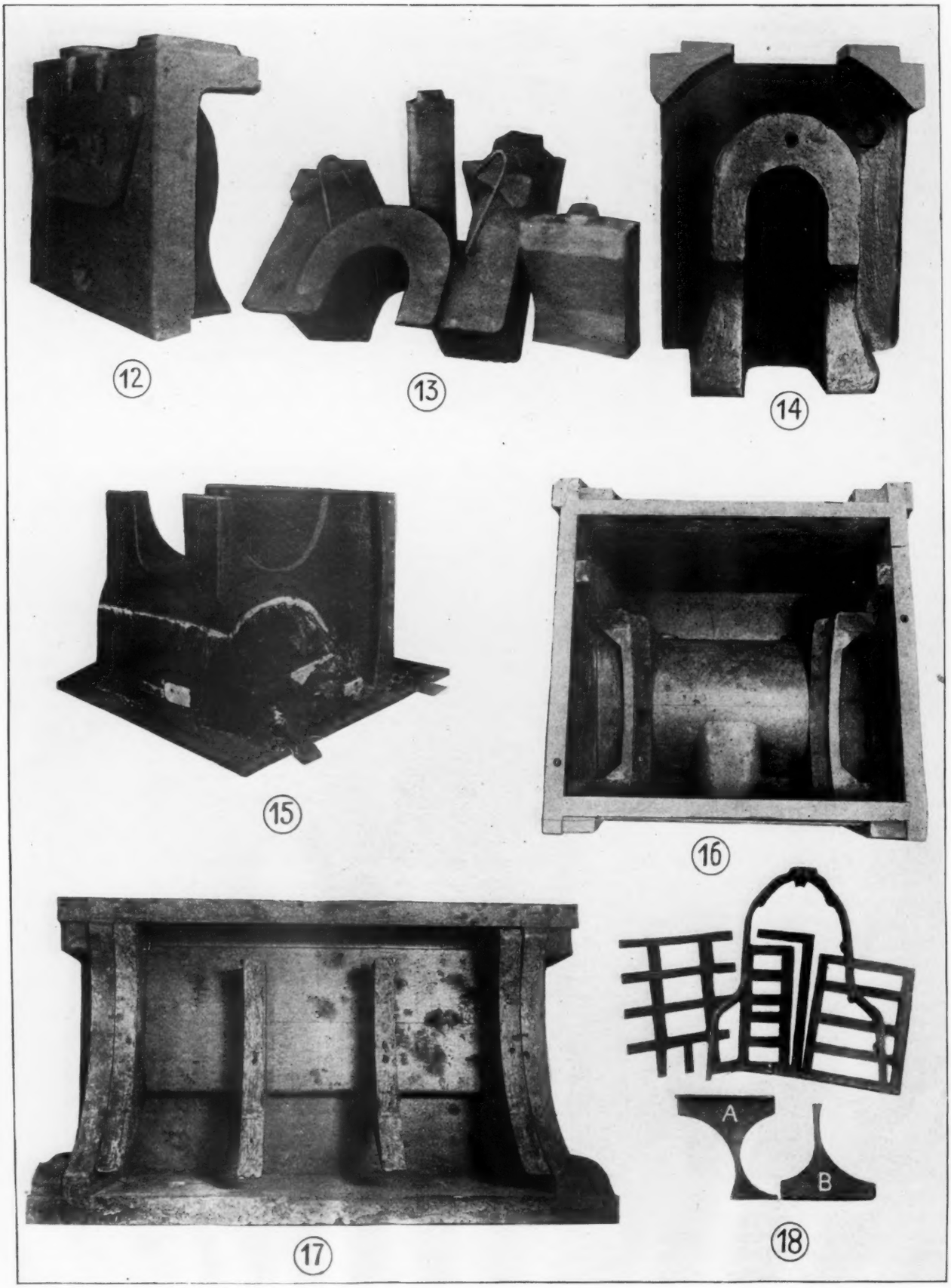


FIG. 11—ARRANGEMENT OF THE MOLD



FIGS. 12, 13 AND 14—CORES USED FOR FORMING SADDLE; FIGS. 15 AND 16—CORE AND CORE BOX TO FORM SPACE BETWEEN PISTON VALVE CHAMBER AND CYLINDER WALLS; FIG. 17—CORE BOX FOR CORE WHICH FORMS PART OF SADDLE WHICH FITS TO FRAME; FIG. 18—PATTERNS FOR CORE IRONS

pieces, as shown in Fig. 8. The cylinder barrel core is the last to be set in the mold, and is inserted in the flask through semi-circular openings in the end plates.

In addition to these four principal cores there are six cores whose purpose is to lighten the casting. The space between the walls of the steam and exhaust passages and the outer shell of the casting is formed by cores of this kind. The frame fit, the reinforcing ribs, and the opening between the cylinder and piston valve chamber are also shaped by the use of such cores. Figs. 12, 13, 14 and 15 show a number of cores used for these purposes. The boxes in which two of these cores are made are shown in Figs. 16 and 17.

Fig. 18 shows patterns for core irons. The large irons are used in the core for the exhaust pipe, while pieces *A* and *B* are a part of the core between the cylinder and piston valve chamber. The other patterns are for grids for rectangular cores.

The gates, risers and pouring basin are arranged as shown in Fig. 19. The pouring basin is directly over the saddle and the riser is above the highest part of the cylinder barrel. Three gates and three risers, each in a straight line, and two large vents are provided. In pouring, when the metal appears in the bottom of the riser, the vent plugs are removed. Approximately 700 pounds of iron are required for the casting.

Patching Cement Floors

One of the principal objections to the use of concrete finished floors is the difficulty and cost of successfully repairing places that become worn or damaged. For best results it is usually considered necessary to cut down the worn places at least 1½ inches into the unbroken concrete, under-cut the edges, clean out the dust and loose particles thoroughly, wash with a thin cement grout, fill in with a paste grout and finally float to a level surface a mortar cement and crushed stone or gravel. The patch then must be kept moist for at least a week or 10 days, keeping off all traffic in the meantime.

W. P. Anderson, president of the Ferro Concrete Construction Co., Cincinnati, states that his company uses a mastic material made from a mixture of asbestos fiber and rubber gum. This mixture is applied with a trowel after thoroughly cleaning the damaged surface. Very little cutting of the old concrete is necessary, other than to break off loose particles. The gum can be worked to a feather edge so that it will readily join with the undamaged concrete surface and eliminate the undercutting required with the old style of patch. A patch of this kind can be opened to foot traffic within a few hours and to heavy traffic within a day or two. It thus is possible to repair a much used portion of a mill or factory floor almost over night. The cost varies with the size of the patch, but will amount to from 16 to 18 cents per square foot.

Disc Grinder in the Pattern Shop

By S. L. Cook

Pattern shop equipment has become so standardized that few radical innovations have been introduced in recent years; the attention of patternmakers and builders of pattern shop equipment has been directed toward the improvement of apparatus already in use rather than toward the development of new devices. This tendency has led to an appreciation of the disc grinder as a valuable tool in the pattern shop. When used carefully and judiciously, this equipment has increased the efficiency of many shops.

Many types of machines are being built and most manufacturers recommend a special cement for holding the paper

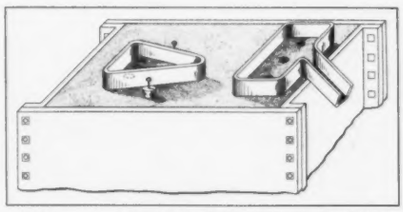


FIG. 19—ARRANGEMENT OF GATES, RISERS AND VENTS

to the discs. Some users of disc grinders employ common shop glue for this purpose. If the plate is heated slightly to prevent the glue from chilling before the paper is applied, such glue proves satisfactory and no trouble is experienced by the loosening of the paper; No. 2 garnet paper seems to be the favorite abrasive among users of disc grinders.

The glue may be removed from the edges of the plate and the paper by using a small pine mallet or some other soft wood. By its use the work can be done quickly and it does not injure the edge of the plate which must be kept square. The customary method of removing the paper is to cover the discs with a layer of sawdust, soaked with water. After a few hours, if the sawdust has been kept saturated, the paper may be pulled from the disc without difficulty.

Before applying a new sheet of abrasive paper, the disc should be cleaned so that the glue, which should be spread evenly over the entire surface, will adhere to all parts of the paper. If an extra set of discs is provided and kept covered with new peper, no time is lost in waiting for the glue to dry.

After the disc has been in use for a short time, it will be noticed, especially if the stock contains traces of pitch, that the paper is glazed. Cutting or grinding then becomes exceedingly difficult. This glaze may be removed easily by scraping the disc with a piece of stiff pasteboard. Care must be exercised in this operation which should not be attempted while the disc is revolving.

Many uses for the disc grinder are found in the course of a day's work. If special jigs are required, it is a good plan to store them conveniently as they may be needed again. One of the most useful jigs is a sliding gage, similar to the cutting-off gage of a circular saw, for work where the trimmer is too small or is not adapted to the piece being handled. On segment work, particularly, the ground joint is found to be more satisfactory than the extremely smooth surface made by the trimmer, since the slight irregularities made by the grinder have the same effect as those made by the toothing plane. The disc grinder eliminates much hand planing and, unlike the plane, is not ruined when it strikes a nail or screw concealed in the wood.

Introducing Phosphorus Into Cast Iron

By G. S. Evans

Question:—Here in Australia the price of pig iron has been increased tremendously and we have been compelled to try various expedients to maintain the cost of our castings at a minimum. We are using very little pig iron, our charges consisting almost entirely of scrap, but we find that the iron is not sufficiently fluid and we would like to know whether we can introduce phosphorus into the mixtures.

Answer:—It is possible to introduce phosphorus into cast iron in a manner similar to that pursued in introducing it into non-ferrous metals, namely, by immersing stick phosphorus in the molten metal by means of a cup fastened to the end of a pipe. These cups are made of graphite and can be obtained from manufacturers of graphite specialties. However, while this method is possible, it is doubtful whether the large amount of phosphorus required to affect fluidity would prove to be commercially feasible on account of the loss sustained and the time consumed in introducing it into the metal. Phosphorous is added to non-ferrous metals in very small quantities with the exception of special phospher bronzes, which command a high price. In the latter case, it is used principally as a deoxidizer, only very small quantities being required. To insure the fluidity of cast iron, more than one-half pound would have to be added for each 100

pounds of metal, of which only about 50 per cent would be retained in the metal to affect its fluidity.

Before using the stick phosphorus it should be immersed for several hours in a concentrated solution of copper sulphate, which forms a coating of copper on the phosphorus and prevents ignition when it is removed from the water. After removing the phosphorus from the solution it should be dried before it is immersed in the metal.

While phosphorus materially affects the fluidity of iron, recent experiments have demonstrated that this element has been overrated in this respect. For example, many foundrymen now are making castings from mixtures containing from 0.25 to 0.55 per cent phosphorous, which formerly were made from metal containing 1.25 to 1.50 per cent of this element and are obtaining much better results than heretofore. This is accomplished by a careful study of the properties of the different grades of irons, by making the mixtures meet the peculiar requirements of the castings and by regulating the mixture and cupola practice to obtain clean, unoxidized metal.

Saving a Few Dollars

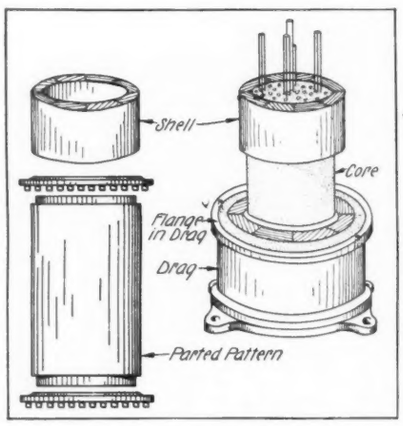
By Emil B. Horne

Recently we received an order for 100 cylindrical castings, 2 x 5 feet, which had 24 bolt holes in each end flange. It was decided to reduce the core cost as much as possible and it was concluded to make a shell for the core, of the same inside diameter as the inside diameter of the pipe. The pattern was parted, as shown in the accompanying illustration, and a three-part flask was employed with a plate fastened underneath the bottom of the drag section. The lower flange first was molded and then the barrel of the pattern was placed on top of this. The cheek flask was slipped over the pattern and after this was rammed, the upper flange was molded and covered by the cope flask.

After removing the cope, the flange and barrel patterns were drawn and the cheek part of the mold was lifted off. The lower flange was left in the drag, onto which the shell was placed. The gate was laid with a sprue in the center and four rods were placed around it to stiffen the core. Several rings also were bedded-in to make the mold more rigid. Since the shell was only 2 feet high, the core was rammed to this height, then moved upward, additional sand rammed and this operation was proceeded with until the required height of the core was obtained. The core then was blacked and was baked in the oven while the barrel and cope were skin-dried. In the center of the core, molding sand was rammed and around this a ring of small pieces of coke, followed with a layer of molding sand and on the outside surface of the core, facing sand was employed. Making the molds in this way constituted practically a day's work, each casting having weighed about 700 pounds. The economies effected in doing this work in this way were considerable.

Recovery of Secondary Metals in 1915

The value of the copper, lead, zinc, tin, aluminum and antimony recovered in the United States from scrap metals, skimmings and drosses in 1915 was $114,304,930, against $57,039,706 in 1914, a 100 per cent increase. This large gain was caused by greater recoveries and much higher average values for all metals. Increased traffic on the railroads and a large demand for metal products, particularly for those to be exported, made 1915



SHELL, PARTED PATTERN AND METHOD OF MAKING CORE FOR A CYLINDRICAL MOLD

the most prosperous year in the waste metal trade.

The imperative demand for zinc and copper by munition manufacturers and for foreign trade made spot metal very scarce. Secondary metals not desired for these purposes were generally available for domestic uses when virgin metal could not be purchased for prompt delivery. The incentive of high prices caused all metal wastes to be more carefully saved, segregated and refined. Many manufacturers who had considered virgin metals only as suitable for their needs found that they could use considerable scrap provided they selected suitable material and used good judgment in its treatment.

The increased output of secondary tin, lead and aluminum, says a statement issued by the United States geological survey, was normally to be expected under the improved conditions of business, and the proportionally larger increase in the recoveries of zinc, copper and antimony were due in part to the foreign demand for pig metal or for manufactured goods containing the metals named.

The output of secondary copper, including that in brass and other alloys, was 196,000 tons in 1915 against 128,000 tons in 1914. The value of this copper and brass amounted to more than $70,000,000.

The secondary lead recovered in 1915, including that in alloys, was nearly 79,000 tons, an increase of 28,000 tons, a quantity exceeded by the primary domestic output of only three states—Missouri, Idaho and Utah.

The amount of secondary zinc recovered in 1915 was 92,575 tons, of which 29,764 tons were recovered by redistallation from drosses and skimmings. At least 4,000 tons of zinc chloride and 46,000 tons of lithophone were manufactured. The zinc used in these products is derived mainly from zinc drosses and skimmings.

The output of secondary tin increased from 12,447 tons in 1914 to 13,650 tons in 1915 and was equal to 24 per cent of the tin imported as metal or as oxide into the United States.

The average price of antimony was abnormally high and the secondary recoveries in 1915 amounted to 3,102 tons, valued at $1,811,568, an increase in quantity of 355 tons and in value of about $1,367,000.

Aluminum was both scarce and very high priced the latter part of 1915 and the secondary metal recovered, 8,500 tons, was valued at $5,802,000.

Annual Convention of the Electro-Platers' Society

The fourth annual convention of the American Electro-Platers' Society, which was held in Cleveland, July 6, 7 and 8, was attended by more than 100 members from the United States and Canada. The president reported that the society had passed through an unusually successful year and that its strength was rapidly increasing. The total membership at present is 618. Officers for next year were elected as follows: President, H. H. Williams, Quick Meal Stove Co., St. Louis; vice president, Oscar Servis, Felt & Tarrant Co., Chicago; secretary and treasurer, Walter Fraine, National Cash Register Co., Dayton, O., and editor, H. J. Richards, Koken Barber Supply Co., St. Louis. The convention will be held in St. Louis next year. One of the features of the meeting was an exhibition of plating accessories.

THE BRASS FOUNDRY

Chemistry in the Brass Foundry---III

By E P Later

COPPER is one of the main constituents of a large number of very useful alloys, those broadly known as brasses—alloys of copper and zinc,—and bronzes — combinations of copper and tin,—finding employment for a great variety of purposes. In these the amount of copper varies from approximately 55 to 60 per cent, to 95 per cent or more, depending on the nature of the alloy; in addition, copper is found in smaller quantities in many other alloys, being added to give certain desirable properties.

In addition to this, however, copper, as the more or less pure metal, is in great demand in many lines and commands, even in normal times, a comparatively high price; therefore, it is not strange that its price practically determines that of its principal alloys. The estimation of copper is of much value to the foundryman, and as it is one of the most easily determined metals, the methods used for this purpose will be given in this article.

Methods of Determination

Copper may be estimated by electrolytic, volumetric or gravimetric methods, each of which may present certain advantages under certain conditions; therefore, the selection of the one to be followed will depend somewhat on circumstances.

In point of accuracy, and perhaps ease of manipulation, the electrolytic method leads all others, although the apparatus required, the platinum screen and spiral, is rather expensive.

Assuming that the copper is in solution, and no interfering metals are present, the platinum electrodes should be cleaned by washing and heating to redness in a bunsen flame, or immersing in a hot potash solution, rinsed in distilled water, then dipped in alcohol, in ether, and dried; the screen then should be dried for a few minutes in a hot oven, cooled in a dissicator and weighed, exercising care not to handle it after it is cleaned.

When a beaker or electrolyzing cylinder is used, it may be supported on wooden blocks or on a ring stand and the electrodes held by clamps attached to other ring stands, or by any other suitable means, taking care that short circuits are not produced by some of the parts which carry current coming into contact with others. Whatever the arrangement, it should permit of the beaker being lowered and removed without breaking the circuit or disturbing the electrodes.

Sometimes a platinum dish is used to hold the solution, being made the cathode and the metal deposited on it, a scheme which is not without some merit, inasmuch as the dish may be used also for a variety of other purposes. In this case the dish is supported either upon the ring of the ring stand, or upon some other suitable metal support, which is connected to the negative side of the battery or source of current.

The solution to be electrolyzed should have a volume of 125-150 cc. and should contain about 4 cc. of strong nitric and one of sulphuric acid. When everything is ready the electrodes are immersed in the solution, putting the spiral inside the screen, and connected up, making the screen or dish the negative or cathode. From 0.5 to 1 ampere will give the best results. Several hours will be required for complete deposition and the electrolysis may conveniently be allowed to run all night. A stronger current will shorten the time required, but there is danger of producing a burned, crumbly deposit if too heavy a current is used. Rotation of the anode also is resorted to and reduces the time considerably.

Evolution of Gas

It will be noted that there is a slight evolution of gas from the electrodes and as this may cause a slight loss from spattering, it is advisable to cover the beaker with two small pieces of glass.

The solution gradually becomes lighter and finally colorless; then the cover glasses and sides of the beaker should be washed down with a jet from the wash bottle, after which the electrolysis may be continued for about a half hour. A few drops of solution may then be removed, placed on a piece of white paper or tile and touched with a drop of sodium sulphide or ammonium sulphide solution, when absence of a distinct blackening may be taken as evidence that all copper has been removed.

The beaker containing the solution then should be lowered and removed without breaking the circuit, after which the electrodes should be washed well with a jet from the wash bottle, or immersed in a beaker of distilled water, then disconnected and the screen dipped in alcohol and ether, dried and weighed. The increase over the previous weight is the copper which has been deposited and from this the amount present in the sample may be calculated, as will be shown later.

Iodide Method

There are several volumetric methods which may be used in determining copper, and of these, what is known as the iodide method is perhaps most worthy of consideration. In principle it depends on the oxidation by sodium thiosulphate of the iodine set free when a solution of potassium iodide is added to a solution of a copper salt containing a considerable excess of acetic acid. Cuprous iodide is precipitated at the same time.

It may be interesting to note that this method is one of a number wherein the substance actually sought, copper in this case, is not titrated or estimated directly, but by adding some other material to the solution certain reactions take place and by determining how much of the material is required to form the new combinations, it is easy to calculate how much of the sought for element is present.

This method requires a standard solution of sodium thiosulphate, which may be prepared by dissolving 19.5 grams of the pure salt in a little distilled water, then transferring this solution to a liter flask and diluting exactly to the mark with distilled water, shaking well to insure thorough mixing. The actual strength of this solution must be determined by tests, using pure copper foil.

Weigh carefully two samples of the foil, approximately 0.2 g. each, place in

separate flasks and add to each about 5 cc. of strong nitric acid. When the copper is in solution, about 10 cc. of distilled water should be added and the whole boiled to expell all red fumes, after which 25 cc. of distilled water are added, followed by a slight excess of ammonia, ordinarily about 5 cc. will be enough. Boil again until the excess of ammonia is driven off, as evidenced by the faint odor, or a change of color, and add a slight excess of strong acetic acid, that is, several cubic centimeters more than enough to neutralize the ammonia. The boiling should be continued for a minute or two, or longer if necessary, to take any undissolved residue into solution. Cool down to room temperature and the solution will be ready for the addition of the potassium idodide solution.

Before this is done, however, clean out and rinse one of the burettes with distilled water. Remove the glass stopcock and rub a little vaseline over it, then replace. Pour in a small quantity of the thiosulphate solution, place a thumb over the upper end of the burette and invert, so as to allow the liquid to flow all over the inside of the tube and take up any water present. Drain this off and fill with the thiosulphate solution, then let the excess of it run out until the lowest part of the curved surface at the top of the column, known as the meniscus, exactly coincides with the zero graduation mark on the burette.

Six cc. of a solution of potassium iodide, made by dissolving 50 grams of the salt in about 100 cc. of distilled water, should be added to the copper solution and the whole shaken for a moment to insure complete reaction.

Finding the Copper Content

Next add the thiosulphate solution from the burette, a little at a time, until the deep brown color has changed to light yellow, then pour in enough starch solution to give a decided blue color. Continue the titration cautiously until the blue color fades to a faint lilac, after which add the solution a drop at a time, shaking or stirring, then letting the liquid stand a moment after each addition, until it loses all trace of its blue color. Care must be taken, however, not to add any excess. With a little practise the end point may be determined within a single drop. When the titration is complete the reading of the burette is again taken from the meniscus, as previously explained.

Since the weight of copper taken for analysis and the amount of thiosulphate solution required to titrate the liberated iodine, are known, the value of the thiosulphate in terms of copper may be found by dividing the weight of copper in grams by the number of cubic centimeters of solution required. For example, if 0.204 g. were taken and required 36.1 cc. of thiosulphate solution, $0.204 \div 36.1 = 0.0056$; therefore each cubic centimeter of solution is equivalent to 0.0056 g. of copper.

The thiosulphate changes strength, especially during the first few days and consequently, it should be standardized every two or three weeks.

Making the Starch Solution

The starch solution referred to may be made by grinding 3 g. of starch into a paste with water and pouring it into 500 cc. of boiling water, boiling a few minutes and allowing it to cool and settle. It does not keep well and must be made fresh every day or two. A much better solution may be made according to Low's formula wherein 500 cc. of a cold, saturated solution of sodium chloride, common salt, are filtered, then 100 cc. of strong acetic acid and 3 g. of starch are added and the whole boiled until clear. After cooling, about 25 cc. of water are added to make up for loss by evaporation and it is then ready for use. It will keep indefinitely and gives very sharp end points.

If the operator prefers to use a gravimetric method for the estimation of copper any one of several different procedures may be employed, but what is known as the thiocyanate method is about as satisfactory as any for most purposes, although it is not without certain disadvantages.

The copper solution, from which interfering metals have been removed, is nearly neutralized with ammonia and about 15 cc. of strong ammonium bisulphate solution added, after which it is heated to boiling and 5 or 10 cc. of ammonium thiocyanate solution poured in, stirring constantly until the greenish precipitate, a mixture of cuprous and cupric thiocyanate, turns pure white. The ammonium thiocyanate solution is prepared by dissolving 10 g. of the salt in about 90 cc. of distilled water.

The white precipitate should be allowed to settle for a time, then filtered on a Gooch crucible, washing with hot water until a few drops of the filtrate, the liquid which runs through, does not give a red color when placed on a white surface and touched with a drop of ferric chloride, showing that all thiocyanate has been washed out of the precipitate. The latter then is washed with 22 cc. of strong alcohol diluted to 100 cc. with water, dried at 120 degrees Cent. for two hours, cooled in a desiccator and weighed. The difference between this and the previous weight represents the copper thiocyanate and the weight of copper present may be found by multiplying it by 0.5226.

In preparing the Gooch crucible the suction pump is connected to a water tap and then to the filtering flask by a piece of heavy rubber tubing. The filter tube is run through a rubber stopper, which fits into the neck of the filter flask. A piece of large bore rubber tubing then is slipped over the funnel end of the tube and allowed to project up over the edge of the glass about 2½ inches. When the crucible is forced down into it a short distance, a tight connection is formed preventing the leakage of air.

The crucible is thoroughly cleaned, then placed in the filter tube and prepared asbestos, which has been shaken up in water to form a heavy suspension, poured through it until a compact layer is formed on the bottom. It is best to use only a moderate suction at first, as otherwise the mat may become too hard to filter quickly.

After the mat has been washed with distilled water several times and sucked as dry as possible, the crucible should be dried at 100 degrees Cent. for one hour, cooled in a desiccator and weighed. It should be re-dried and weighed until a fairly constant weight is obtained.

Coming now to the application of these methods to the analysis of a copper-bearing alloy, the procedure is complicated somewhat by the fact that other metals which will interfere with the estimation of the copper, probably are present and must be removed. Inasmuch, however, as a certain metal may interfere in one case and not in another, the manipulation will vary according to circumstances.

Lead as a Precipitate

Assuming that it is desired to use the electrolytic method for the estimation of the copper in an alloy, about a gram of the latter should be carefully weighed out and dissolved in a few cubic centimeters of strong nitric acid, preferably in a 6-ounce flask, as danger of loss from spattering will be much lessened. Eight or 10 cc. of strong sulphuric acid should then be added and the flask shaken with a whirling motion over a free flame until heavy, white fumes are given off freely, then allowed to cool and 30 cc. of distilled water added, afterward heating to boiling and keeping hot for a few moments to dissolve any soluble sulphates. The lead present will remain as a white precipitate. In case any silver is present it may be removed from solution by a drop of strong hydrochloric acid.

The solution then may be filtered, washing the precipitate with cold water, then diluting the filtrate to about 250 cc., warming and passing hydrogen sulphide gas through it to saturation. After the precipitate has settled for a short time it should be filtered off and washed with water through which hydrogen sulphide gas has been passed, this serving to prevent oxidation and solution of the copper sulphide, which would then run

through the filter and be lost. The point of the filter should be pierced and the precipitate washed into a flask with a small amount of water, where it should be gently warmed with a solution of sodium sulphide. This treatment will remove arsenic, antimony, etc., as was shown in previous article.

Removing Other Metals

The undissolved residue is filtered off, washed with water containing a small amount of sodium sulphide, then with hot water. The filter should be pierced, the residue washed into a beaker with a small amount of water and boiled with a few cubic centimeters of dilute nitric acid, one part acid to five parts water, to dissolve the sulphides of copper, cadmium and bisumth. This solution is almost neutralized with potassium hydroxide solution, then a small amount of sodium carbonate solution added, followed by potassium cyanide, about two grams in 10 or 15 cc. of water. The precipitate, bismuth, may be filtered off, washing with hot water. The cyanides present in solution must now be removed, which may be done by transferring it to a large beaker, adding about 10 cc. of strong nitric acid and heating it to boiling for a few minutes. The fumes of hydrocyanic acid are extremely poisonous, so this operation must be carried on under the hood and great care taken not to inhale any of them, as even a very small amount may produce serious results. After it is completed, the solution may be filtered into an electrolyzing beaker, 4 cc. strong nitric and 1 cc. strong sulphuric acid added, then diluted to 125 cc. or so, and electrolyzed as previously described.

This scheme will remove everything which might interfere with the deposition of the copper, but it is rather lengthy and may sometimes be omitted, depending on the composition of the alloy. With the usual run of brasses, containing merely copper and zinc, with small amounts of several other metals, it is generally necessary only to take the metal into solution with nitric acid, remove the lead by evaporation with sulphuric acid, filter, and after adding the proper amount of acid and diluting, electrolyze the filtrate.

In general, arsenic, antimony, bismuth and large amounts of lead interfere with the electrolytic estimation of copper and are liable to be found in alloys; therefore, when their presence is known or suspected, they should be removed according to the foregoing method.

The iodide method for copper possesses the advantage that most of the other metals, when present in reasonable amounts, do not interfere seriously; therefore it may usually be employed for a brass or bronze without much preliminary manipulation.

About 0.5 g. of the alloy is dissolved in 10 cc. of *aqua regia*, 1 part nitric to 3 parts hydrochloric acid, boiling off the excess of acid when solution is complete, then diluting with 45 cc. of water and adding sodium carbonate solution until all of the copper is precipitated as a blue mass. This is dissolved in a moderate excess of acetic acid, boiled, cooled and filtered if a reddish precipitate separates out. The potassium iodide solution is then put in, the liquid shaken and the liberated iodine titrated with thiosulphate as previously described.

An alternative method, which is perhaps safer in that the copper is obtained and titrated in a solution which is practically free from other metals, consists in dissolving 0.5 g. of alloy in 10 cc. of *aqua regia*, cooling it somewhat and adding 5 cc. of strong sulphuric acid. The solution then is diluted with 25 cc. of cold water, a piece of pure sheet aluminum put in and the whole boiled for 10 minutes until the copper is all thrown down. After cooling off a little, 10 cc. of hydrogen sulphide water is poured in, around the sides of the beaker or flask, to insure removal of traces of copper from the solution. The liquid is decanted through a filter, keeping as much as possible of the residue in the flask, and is washed several times by decantation with hydrogen sulphide water. A few cubic centimeters of strong nitric acid are then poured over the aluminum and precipitated copper in the flask and the aluminum removed and rinsed off with hot water. The flask then is placed under the filter and a few cubic centimeters of strong bromine water poured through it. This is prepared by shaking a few drops of bromine in a bottle of distilled water. Bromine is an element, purchased as a deep red, fuming liquid; it is corrosive and dangerous, therefore, it must be handled with care.

Oxidizing the Copper

The treatment with bromine-water oxidizes any copper or copper sulphide which was on the filter, also any arsenic or antimony present in the alloy and precipitated by the hydrogen sulphide.

The filter is washed with hot water; then the solution is taken down to a few cubic centimeters by evaporation, about 5 cc. water and 6 or 8 cc. of ammonia added and boiled, then 8 cc. of acetic acid and 10 cc. of potassium iodide solution are shaken up and titrated with thiosulphate.

With a gravimetric, thiocyanate method, it will usually suffice to dissolve 0.5 or 1 gram of alloy in nitrate acid, cool, remove lead by evaporation with sulphuric acid, again cool and dilute with 30 cc. of water, heat and filter off the lead sulphate, washing thoroughly with cold water. Ammonia then is added until the solution is only faintly acid, followed by 10 or 15 cc. of ammonium bisulphate solution, after which the copper may be precipitated with ammonium thiocyanate solution, filtered on a weighed Gooch crucible, then washed, dried and weighed.

Whatever method is used for the estimation of the copper the results should be expressed as grams of metal found, then by dividing this by the weight of alloy taken for analysis and moving the decimal point two places to the right, the per cent of copper in the sample is obtained. Thus, if 0.5 g. of the alloy was taken and analysis showed 0.41 g. copper to be present, $0.41 \div 0.5 = 0.82$; moving the decimal point gives 82, the per cent of copper in the alloy.

As a means of gaining practice in the removal of interfering metals and the estimation of copper, it will be advisable for the operator to work on one or two brasses and bronzes or other alloys whose composition, or at least copper content, is known, before attempting the analysis of any which are not familiar, as he will then have an opportunity of checking his results with the known facts and thus detect the sources of any serious errors.

Scientific Management in a Brass Foundry

Carl G. Barth, consulting engineer, Philadelphia, recently gave an interesting account of his experiences in installing the Taylor system of scientific management in the brass foundry of the Pullman Co., Chicago.

He prefaced his remarks by deploring the prominence held by the stop watch in the popular impression of scientific management. In actual practice, stated Mr. Barth, the stop watch is one of the last aids enlisted by the efficiency engineer. In one shop with which he had been associated, the number of employes had been increased from 300 to 600, the output more than doubled, and shop methods almost completely changed, yet it would still be some time before he was ready to use the stop watch.

When Mr. Barth was secured to install the Taylor system throughout the Pullman shops, he decided to begin in the brass foundry. This department, being isolated from the rest of the plant, could be reorganized without disturbing the routine in other parts of the shop. He had endeavored to maintain this isolation, and constantly sought to impress on other departments that the brass foundry should be considered as being located in San Francisco, insofar as requisitions and orders were concerned.

No piece of work is being handled in this foundry in the same way that

it was prior to the introduction of efficiency methods. In this change, special emphasis was laid on proper planning of the work and correct routing of materials. Complete instruction cards have been prepared.

The first year's work in this foundry showed a reduction of one-third in the labor costs. On certain small brass fittings for the Pullman car, this reduction amounted to $90. Against this, the indirect or overhead charges had increased only $9. This result, Mr. Barth pointed out, was unusually favorable as it is generally several years before big savings can be expected. The tendency of shop executives to expect appreciable reduction in costs within a few months after the work is first begun, has proved a big stumbling block in extending the science of management. The greatest difficulty confronting the engineer when installing efficiency methods, was in winning the cordial support of the managers, superintendents and foremen.

Mr. Barth laid great emphasis on the necessity of keeping machines and tools in good condition. "Shops which do not make repairs when needed," said Mr. Barth, "but work the old machines, are like a man with a broken arm who continues to work because the arm is still hanging".

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

An Acid-Resisting Alloy

We would like to have a mixture for castings that will resist the action of sulphuric acid. We have heard that an alloy consisting of aluminum, 92 per cent; copper, 5 per cent; bismuth, 2 per cent, and silicon, 1 per cent, gives good results. Before proceeding to make this mixture, we would like to know whether this alloy is satisfactory for this service, and if so, what should be the sequence of the metal additions?

We are unable to state whether the alloy given would withstand sulphuric acid or not, as we never have tested it. The bismuth could be replaced by a small amount of antimony and the silicon omitted, since the latter element is a harmful impurity in aluminum or its alloys. An alloy consisting of 85 per cent aluminum and 15 per cent of tin is reported to possess great acid-resisting properties.

Casting Brass Washers in Permanent Molds

We have received an order for a large number of brass washers, and we would like to know whether they can be cast in permanent molds. It might be possible to cast the entire washer in this way or in halves, since it split apart after being bored and turned. The alloy used consists of copper, 82 per cent and 6 per cent each of tin, lead and zinc.

We do not advise casting this washer in an iron mold, since the alloy which you are using would be covered with cold shuts, small, imbedded pellets of metal and zinc oxide dross. The metals best adapted for casting in iron molds are aluminum and phosphor bronzes and possibly manganese bronze, since these alloys have the requisite fluidity to fill the molds in spite of the rapidly chilling metal. If it is decided, however, to try the iron mold, the casting should be made in halves, since it is evident that the chances of success would be increased by not having the castings contract against cores. However, some finishing would have to be done even in the event of the successful use of iron molds, since the surfaces thus produced are not as smooth as when die castings are made of white metal.

Steam Brass With High Percentage of Scrap

We would like to have a good mixture for steam brass in which a large percentage of scrap can be used. We are using white metal patterns, but the sand frequently adheres to them and we would like to know with what material these patterns can be coated to prevent the adherence of sand.

A good mixture for steam metal to be used with scrap of unknown composition, follows: Copper, 85 per cent; tin, 5 per cent; zinc, 5 per cent, and lead, 5 per cent. Half scrap and half new metals would give you a mixture consisting of an unusually high percentage of scrap and, therefore, the exact composition of the resulting castings would be an unknown quantity. However, this might be immaterial in this instance. When castings of a specific analysis are required, however, the only manner in which miscellaneous scrap can be used is to melt it in a reverberatory furnace, casting it into ingots which then are analyzed and are used in the proper proportion to make the alloy specified.

Coat the white metal patterns with beeswax by slightly warming them and brushing them with a hard brush that previously has been scrubbed with a lump of beeswax.

Acid Dip for Red Brass

Kindly give us a formula for a bright acid dip to be used for red brass castings made from a composition of scrap which contains approximately 5 to 8 per cent of lead.

Clean all sand from the castings and dip in a hot solution consisting of 50 per cent nitric acid and 50 per cent water. Wash first in cold running water, then in hot water, and dry in sawdust. This will dissolve any lead spots that may show on the castings, after which, if they are not sufficiently bright, they may be redipped in the following bright dip: Nitric acid, one gallon; sulphuric acid, one gallon, and common salt, one ounce. Use this dip cold, and rinse and dry the castings again.

Lead Return Bends

We would like to have your opinion as to the most simple and satisfactory way of molding 6-inch return bends in lead. We have quite a number of these castings to make and thought that possibly a cast iron mold could be used for the outside, but are skeptical as to what effect such a mold would have on the casting in the way of blowholes or cold shuts. We also would like to obtain a good mixture for the core.

As the temperature of the lead is too low to burn the binder in the core, a soft mixture is necessary. Otherwise, it would be difficult to remove the sand from the casting. A soft core with a hard skin is required. The following will be satisfactory: Mix one pound of starch with two ounces of powdered glue and dissolve in two quarts of water. Heat and gently bring it to the boiling point, stirring until it jellies. Then add dry silica

sand to the mixture and it will temper to a molding consistency without the addition of any water. When the cores are ready for the oven, spray well with molasses water to form a hard skin. This sand can easily be removed from the castings, either dry or by immersing in water. The molds can be made in sand, well rammed, or in a cast iron mold, depending upon the quantity to be made. The cast iron mold will produce a smoother casting and after the mold becomes heated no difficulty need be anticipated from blow-holes or cold shuts in the case of lead containing 5 per cent antimony.

Changing the Color of Yellow Brass

We would like to obtain a solution in which we can dip common yellow brass nuts so as to give them a red brass tint. Can you give us a formula for a solution which will perform this work?

To change the color of yellow brass, it will be necessary to pickle the castings in an oil of vitriol solution to dissolve the zinc from the surface of the metal. The pickling solution is made by adding one gallon of oil of vitriol, or sulphuric acid, in nine gallons of water. The acid should be added to the water gradually while the mixture is being stirred with a glass rod or a piece of wood. An earthenware container should be employed which will not be attacked by the acid. The castings should be immersed in the solution several hours, if necessary, to produce the desired color, and after removal, should be rinsed in running water, then in hot water, followed by drying in sawdust.

Government Bronze

Kindly furnish us with the following mixtures of government bronze: No. 1, tensile strength not less than 28,000 pounds per square inch; No. 2, tensile strength not less than 35,000 pounds per square inch, and No. 3, tensile strength not less than 45,000 pounds per square inch.

A mixture that will meet the requirement of 28,000 pounds per square inch tensile is as follows: Copper, 89 per cent; tin, 5 per cent; lead, 3 per cent; zinc, 3 per cent. For 35,000 pounds per square inch the following alloy will be satisfactory: Copper, 88 per cent; tin, 10 per cent; zinc, 2 per cent. For 45,000 minimum the following alloy can be used: Copper, 55 per cent; 30 per cent of 2.5 per cent manganese-copper; zinc, 40 per cent; tin, 1 per cent; iron, 1 per cent; aluminum, 0.5 per cent.

Alloying Magnesium With Aluminum

We would like to know how to make magnesia aluminum bronze for the manufacture of piston heads. We would also like to have you advise us how to mix magnesia with aluminum.

Magnesia cannot be mixed with aluminum, since it is an oxide and aluminum is a metal. Furthermore, magnesia is a metallic oxide, generated at a higher temperature than the oxide of aluminum. Therefore, the latter metal has no reducing action upon magnesia, not having the power to deprive the magnesia of its oxygen and liberate the metal, magnesium. The latter, however, is alloyed easily with aluminum and when mixed with it in the proportion of about 7 per cent, makes a strong, ductile alloy. This alloy should contain 93 per cent of aluminum and 7 per cent of magnesium. To obtain the best results in casting this alloy, permanent molds should be employed. When making the alloy the aluminum should be melted first, after which the magnesium is added, the bath being stirred thoroughly.

Pin Holes in Yellow Brass

Recently we cast two yellow brass altar gates, each about 2 feet 6 inches square, which were ornamented on the face and weighed about 75 pounds each. The metal thickness in the frame was ½-inch; the section of the ornamented surface was ⅛-inch. The mold was made from a plaster model, French sand having been used. The mold was baked in the core oven and tilted when cast. The metal had to be carried about 300 feet, but both castings apparently were perfect when shaken-out of the sand. However, as soon as the surfaces were buffed and polished, a large number of small holes were uncovered underneath the skin which were filled with burned sand; the face of the castings did not contain this defect. These holes were cleaned and plugged, but the job, of course, was not satisfactory. We would like to know what caused these small holes underneath the skin.

If the holes in question were filled with burned sand, as stated, it is evident that particles of sand had washed from some other part of the mould, probably from the vicinity of the gates. There is a chance, however, that some mistake has been made about the sand being in the holes, since if the holes occurred on the cope side of the casting, they probably were due to the manner in which the mold was vented. It frequently happens that holes are found under vents on thin castings, caused by the metal having been forced by the pressure into the vent. The remedy is to so use the vent wire that it cannot touch the pattern, which can be accomplished by affixing a stop button on the wire to gage the depth to which it can penetrate the mold.

High Pressure Bronze

We are considering the manufacture of bronze castings which must withstand a pressure of approximately 5,000 pounds per square inch. We have considered the use of gun metal, copper 88 per cent, tin 10 per cent, zinc 2 per cent, but are under the impression that if the tin were increased the castings could be subjected to even greater pressure. Is this a fact? Also, we have considered the use of 0.5 per cent of manganese copper for fluxing purposes. Do you think it would be advisable to use this material?

The alloy generally employed for hydraulic casting work consists of copper, 86 per cent; tin, 13 per cent, and zinc, 1 per cent. The castings made from this mixture will withstand an hydraulic pressure of 6,000 pounds per square inch, but such metal must be sound and free from all oxides. We believe that the addition of 0.5 per cent of manganese copper would be excessive, but this can readily be determined by casting a test bar, approximately 2 inches square, notching it in the center with a hack saw to a depth of ¼ inch, and then breaking the bar for examination of the fracture. If the latter is clean and the metal homogeneous, and if the casting runs well, 0.5 per cent of manganese-copper can be employed. However, if the metal is not satisfactory, reduce the amount of manganese-copper. We believe that probably 0.125 per cent of 30 per cent manganese-copper would be sufficient. It should be alloyed with the zinc first, in correct proportions, so that the addition of 1.5 per cent of zinc will add the deoxidizer and also will carry sufficient excess zinc for volatilization.

A High Speed Bearing Bronze

We would like to have a mixture for high speed bearing bronze.

The following alloy will be found satisfactory for the purpose outlined: Copper, 77.50 per cent; tin, 12 per cent, and lead, 7.50 per cent, together with 15 per cent of 3 per cent phosphor-copper. Melt the copper under a cover of fine charcoal and when it is thoroughly fluid, add the phosphor-copper, then the tin and finally the lead. Stir the mixture thoroughly.

Fred S. Campbell's Inter-changeable Match-Plates

By the Use of Simple, but Ingenious Frames This Labor-Saving Molding Method is Greatly Simplified

Fred S. Campbell, the man behind the inter-changeable match-plate process

THE match-plate method of molding has been accorded universal recognition and now is in general use in the production of a wide variety of castings. Match-plate construction by reason of the simplicity of the principles involved, has not proved susceptible of many far-reaching improvements. Such advances as have characterized the development of the match-plate system, as a rule, have embraced devices to prevent the shifting of molds to insure clean lifts, the application of molding machines to afford a maximum output, the designing of handy and efficient flasks and other improvements in the equipment used in conjunction with match-plates. Such considerations as reducing the cost of match-plates, provisions for varying the combinations of patterns in the same flask and eliminating the necessity of making a complete match-plate for each separate pattern or group of patterns, generally have not received much attention.

Of exceptional interest, therefore, is a new match-plate process devised by Fred S. Campbell, superintendent of the Hitchings & Co. foundry, Elizabeth, N. J. The essential feature of the Campbell system is that the match-plates, instead of being constructed in complete and independent units, are designed for use in frames in which one or more match-plates may be assembled simultaneously. The match-plates are provided with flanges which fit accurately into slots inside of the frames, the latter being provided with adjustable flask pin guides and vibrator connections. Therefore, when assembling the desired match-plates in a frame, a complete unit is obtained which is ready for molding. By this arrangement, almost any desired combination of castings may be obtained daily from each molding floor, thus affording great flexibility of output, and making it possible to concentrate on the production of the casting for immediate requirements. Practically no time is lost in varying the combinations of castings, since the patterns may be inserted and removed from the frames with great rapidity. This process effects great economies by eliminating the necessity for adjusting each match-plate to the flask. Such adjustments are restricted to the frames, and only a few of the latter are required to accommodate a wide range of patterns. Economy also is effected by the reduced consumption of aluminum in making match-

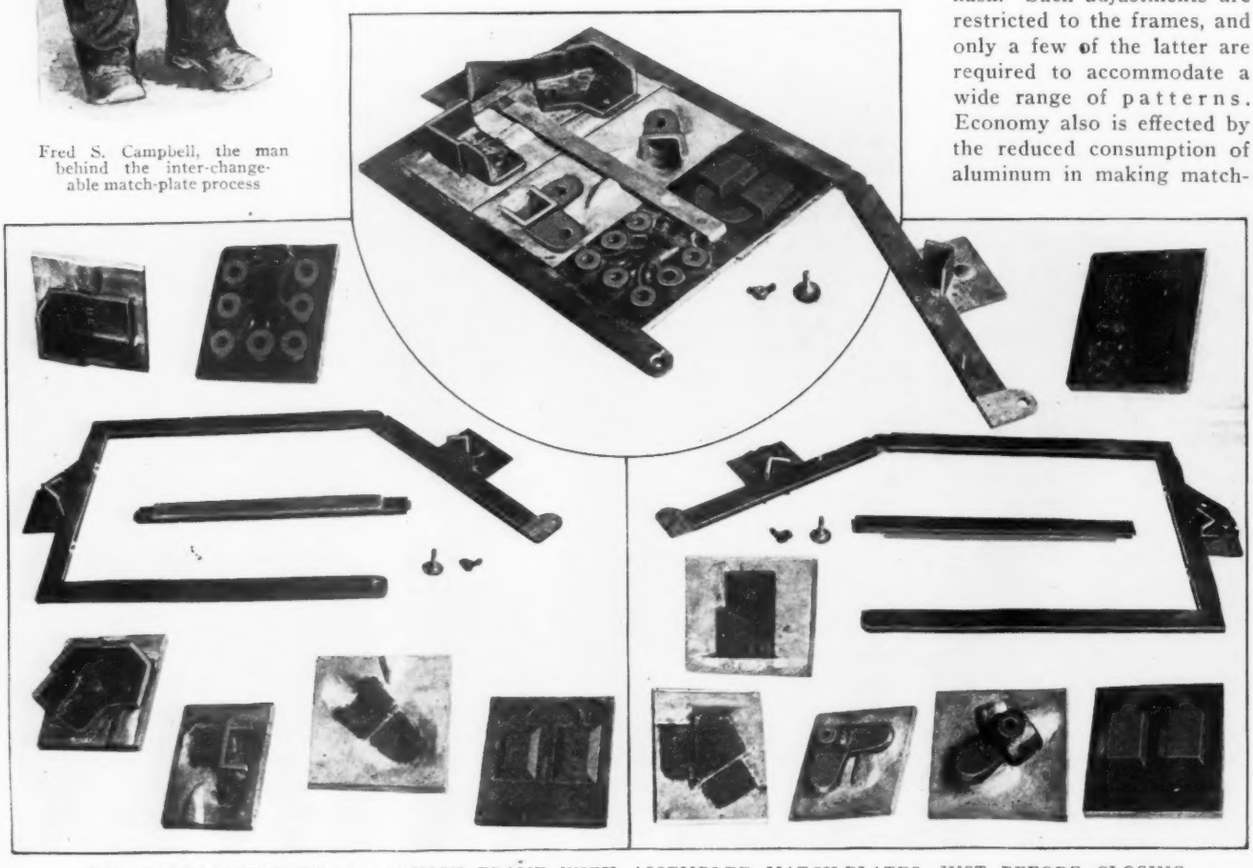


FIG. 1—DRAG SIDE OF 12 x 15-INCH FRAME AND DRAG SIDES OF SIX MATCH-PLATES FOR TYPICAL GREENHOUSE CASTINGS

FIG. 2—DRAG SIDE OF 12 x 15-INCH FRAME WITH ASSEMBLED MATCH-PLATES, JUST BEFORE CLOSING

FIG. 3—COPE SIDE OF 12 x 15-INCH FRAME, WITH ITS SIX MATCH PLATES

plates for this system, a feature of particular advantage at present, in view of the high prices prevailing for this metal. Another advantage of the Campbell method is that it is practical and economical to make a match for a job requiring only a small number of castings. The match-plate frame merely serves the purpose of holding the match-plates in position, and of separating the cope and drag sections of the flask the required distance. Briefly, the frame is a detachable portion of the match-plate which, in former practice, has been constructed integral with the latter. The frame is built of flat steel strips in three layers which have the same aggregate thickness as the match-plates in conjunction with which the frame is used. The middle layer, or core, is provided with the flask pin holes and with a bolt hole to which the vibrator may be connected. This layer is in two parts, one comprising three sides of the rectangular frame and the other the fourth side. The top and bottom layers each consist of four members, which are strips of steel riveted to the middle layer. In the two longer sides of the frame, the interior edges of the top and bottom layers overlap the middle layer, thus forming grooves or slots into which the flanges of the match-plates slide and may be held securely. The pin which connects the swinging side to the remainder of the frame is riveted into a hole countersunk on both sides, thus making a rigid joint; in this joint the inner layer of the swinging side is overlapped by the top and bottom layers of the side to which it is jointed. The free end of the swinging side fits into the adjacent side of the frame in the same manner and is locked into place by a pin provided with a thumb screw after the match-plates have been inserted; the pin hole is tapered and the head of the pin has a slot which grips a small lug adjacent to the pin hole, thus preventing the pin from working loose. The match-plates are designed to fit into the frames as accurately as possible. In order to prevent shifting, and to insure the efficient transmission of the waves of force from the vibrator, the inner face of the side nearest the vibrator connection is provided with set screws which are screwed up tightly against the end of the match-plate. As a further precaution against shifting, the pin hole blocks of the frames are provided with pin guides which may be adjusted to the flask pins by machine screws. The problem of gating the molds has been solved in an interesting manner. All patterns cannot be gated alike; some must be gated in the cope and others in the drag. Naturally, it would prove impractical to assemble patterns in the same frame unless they were gated alike; therefore, to permit of using all match-plates of the same size interchangeably, all gates, whether in the cope or drag, are connected to a runner located centrally in the drag. The runner prints are embodied either in the match-plates themselves, or in the removable bar of the frame, depending on which of the two types of frames is used. The accompanying illustrations show two of the frames employed at the Hitchings plant, together with typical interchangeable patterns which may be assembled in them as desired. Figs. 1, 2, 3, 4 and 5 show a 12 x 15-inch frame and a portion of its match-plate equipment. This frame is provided with a removable bar which dovetails into the end members. When the bar is in place, the frame may contain two, four or six match-plates, depending upon the size of the plates, as shown in Fig. 5; this frame also may be employed for large match-plates by removing the bar. With this frame, there-

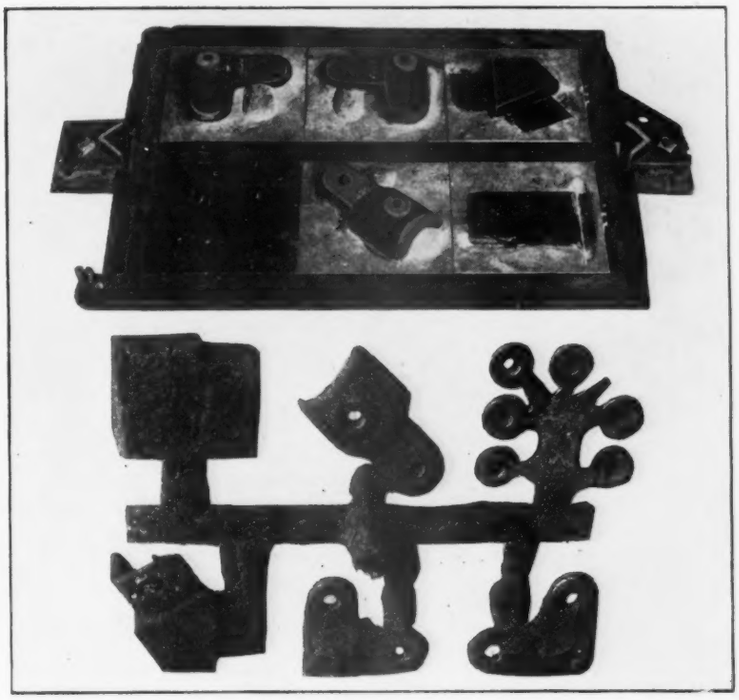


FIG. 4—COPE SIDE OF 12 x 15-INCH FRAME AFTER ASSEMBLING AND CLOSING, AND A GATE OF CASTINGS PRODUCED WITH THIS MATCH-PLATE

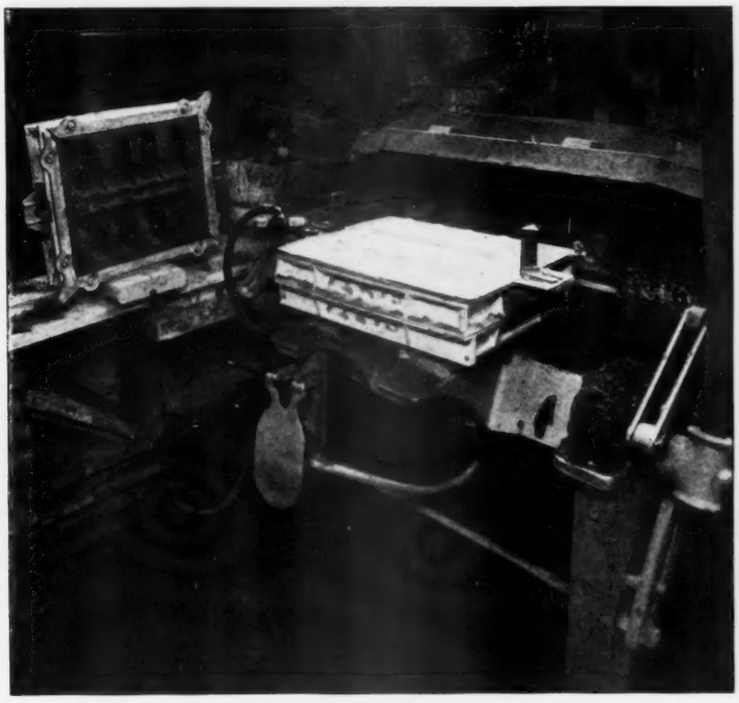


FIG. 5—RAMMING MATCH-PLATE MOLD ON HAND SQUEEZER, SHOWING COPE SIDE OF 12 x 15-INCH FRAME WITH A SINGLE MATCH-PLATE ON WHICH EIGHT SPLIT TEE PATTERNS ARE MOUNTED

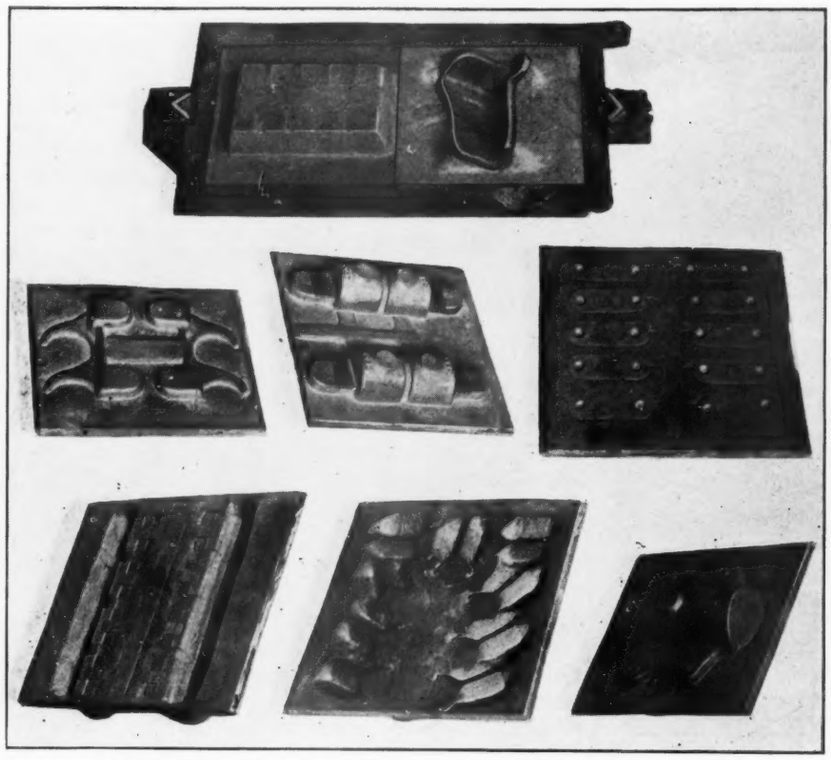


FIG. 6—DRAG SIDE OF 12 x 18-INCH FRAME WITH ASSEMBLED MATCH-PLATES. THIS ALSO SHOWS DRAG SIDES OF SIX OTHER MATCH-PLATES FOR TYPICAL GREENHOUSE CASTINGS

fore, it is possible to make one, four, six or more castings from different patterns in a mold, since some of the match-plates are provided with more than one pattern. When using the removable bar, the combination of match-plates may be varied as often as necessary. Figs. 6 and 7 show a 12 x 18-inch frame and match-plates which are used in it. Two plates may be assembled in this frame.

Output Increased

The output per man for six hours with this equipment, depending on the number of cores required, ranges from 120 to 160 molds, including 15 to 20 changes of patterns, if necessary, since such changes may be affected with practically no loss of time. This output compares with 60 to 70 molds a day, formerly obtained with ordinary snap flasks and loose patterns mounted on boards. For handling the new equipment, skilled molders are not required, the best results having been obtained by the employment of handy men on this work.

The flasks are of the tapered type and may be fitted with upsets of any required depth. They are provided with adjustable pin guides to insure the accurate location of the cope on the drag. The molds are made on hand squeezers, the sprues being made by prints on the squeezer plates. The squeezer plates are tapered, thus reducing the amount of sand required per mold.

Making the aluminum match-plates at the Hitchings plant is a comparatively simple process. As many master patterns as are required are mounted on a board, being molded in a snap flask which is several inches longer and wider than the desired match-plate. The cope is lifted off and two wood frames, each having the same thickness as the match-plate, usually 5/16 inch, are placed on the drag. One of these has the same dimensions as the flask, while the measurements of the other correspond to those of the match-plate, plus an allowance for shrinkage. The latter frame is centered over the impressions in the mold, and two cast iron chill pieces, containing slots for forming the guide lugs or flanges on the match-plate, are placed against two parallel sides of the frame; to eliminate the possibility of shifting, the chill pieces are pinned by nails which are driven into the sand.

Shrinkage Allowance

In order that the allowance for shrinkage may be regulated within narrow limits, one of the sides of the frame against which the chill pieces are placed is provided with small wood screws which may be moved in or out, as desired, thus insuring the accurate placing of the chill pieces. The remaining space between the two frames then is filled with sand and leveled off, a gate is cut and the smaller wood frame is lifted out. A sprue then is cut in the cope and the mold is closed. The mold is poured with No. 12 aluminum alloy, the best results being obtained by pouring the heat when the metal is a silvery color. The casting is finished on a buffing wheel and then is

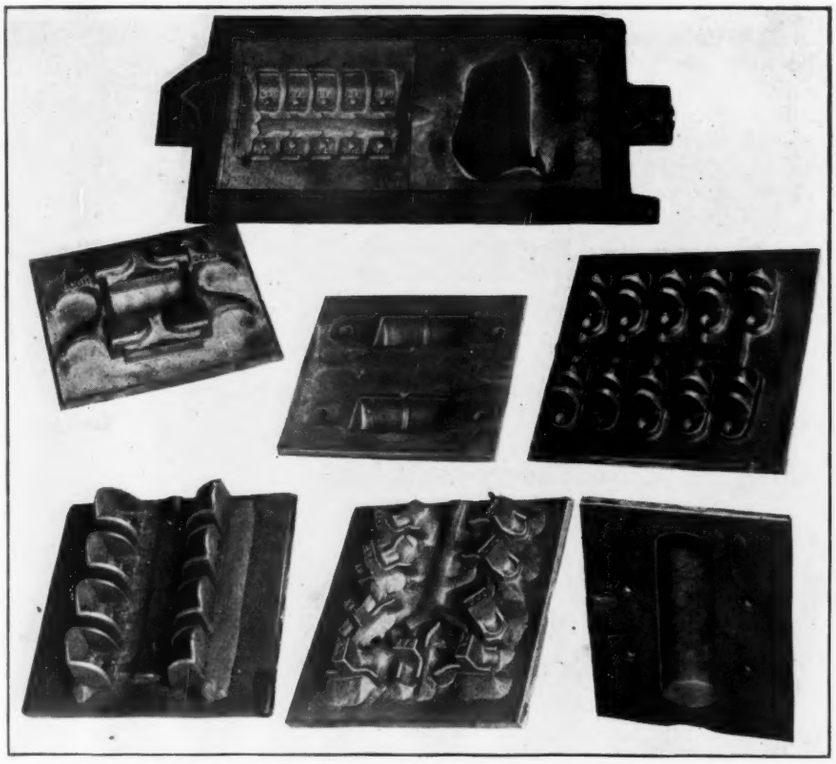


FIG. 7—COPE SIDES OF ASSEMBLED, 12 x 18-INCH FRAME AND OF OTHER MATCH-PLATES FOR USE IN THIS FRAME

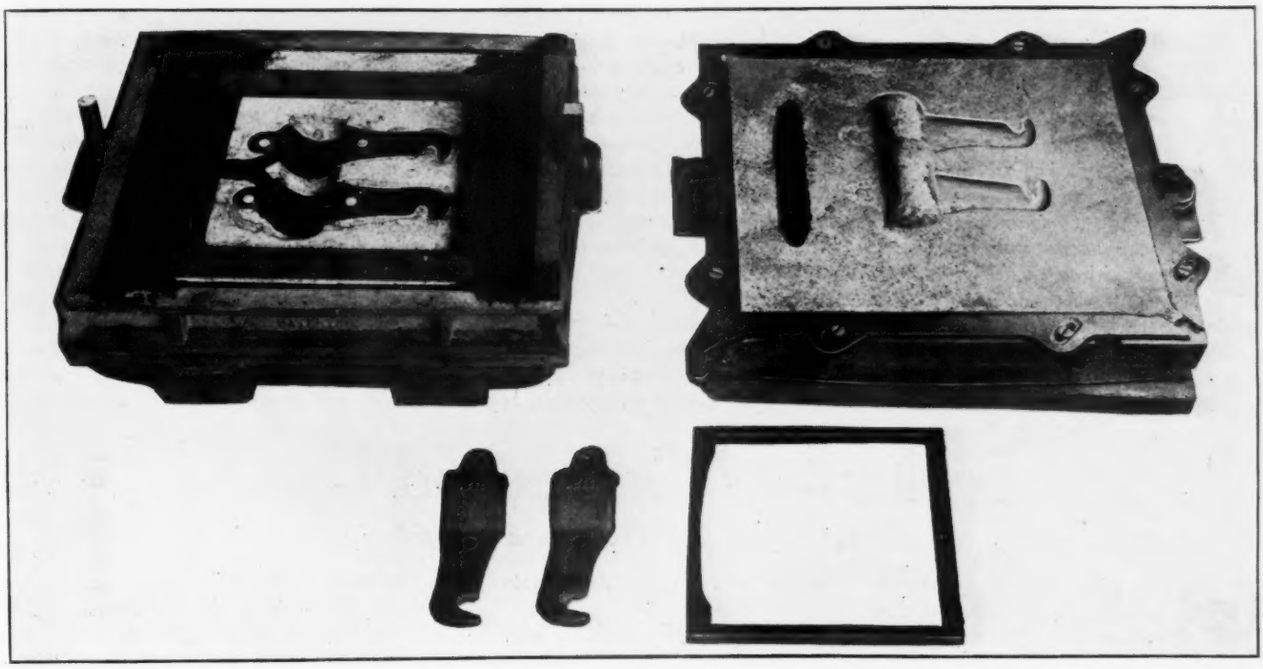


FIG. 8—MOLD FOR MAKING AN ALUMINUM MATCH-PLATE, SHOWING SLOTTED CHILL PIECES IN DRAG, AND PATTERNS AND WOOD STRIKE-OFF FRAME IN FOREGROUND

ready for service; in rare cases the guide lugs have to be machined on a planer to make them fit the grooves in the frames. The molding time averages 45 minutes and a match-plate usually is ready for the frame in 1 to 1½ hours from the commencement of molding, including all operations. The facility in making match-plates contributes in a notable degree to the success of the Campbell system. In one typical case, a rush order for a large number of small greenhouse castings was received early one morning. A match-plate was cast in 45 minutes and within an hour was in the molder's hands. The latter, in that day's heat, had 100 molds credited to him, each containing four of the greenhouse castings in addition to 16 castings from a hardware pattern which was put up simultaneously. Due to the rapidity with which match-plates may be made and placed in the sand, it is proving profitable to mount patterns on match-plates when only a very few castings are required.

Sand-Cast Alloy Specification Difficulties

By W M Corse

IN CONSIDERING the subject of specifications for non-ferrous alloys, a difficulty has arisen in securing sufficient reliable information from experience tables to enable the committee on Sand-Cast Metals and Alloys to recommend specifications which would be authentic. A comparatively small amount of work has been done on non-ferrous alloys, and the need for information among engineers is very great, as shown by the almost continuous stream of inquiries that come to such places as the bureau of standards at Washington. The data from which replies could be made are very meager and not always reliable.

In order to improve conditions a suggestion was made that the committee publish such information as it had with the idea of adding to it from time to time. At the committee meeting at which this matter was discussed, it was deemed advisable, on account of the lack of sufficient experience tables, to defer the publication of such information until more data could be obtained. This action was prompted largely by the fact that many people refer to the *Proceedings* of the American Society for Testing Materials for fundamental data for preparing such specifications, and such people might assume that publication of information, such as mentioned, was authentic, when it was really published to arouse interest in the subject and to stimulate the sending in of further results for checking purposes. The idea was to publish such information as was secured by the ordinary physical tests, such as ultimate tensile strength, proportional limit, elongation and reduction of area, which are not so difficult to obtain.

The main difficulty is in getting the exact history of the samples on which the tests are made. Variations in foundry practice cause variations as high as 25,000 pounds per square inch in alloys which have a maximum tensile strength of 50,000 pounds per

Symposium on Non-Ferrous Metals and Alloys

At the annual meeting of the American Society For Testing Materials, held at Atlantic City, June 27 to 30, a symposium on "Non-Ferrous Metals and Alloys" was submitted by the committee authorized to consider specifications for metals. The symposium consisted of three papers and reports, as follows: "Spelter, its Grades and Uses," by G. C. Stone, W. H. Bassett and M. N. Price; "A Review of the Tin Situation," by L. Addicks and W. A. Cowan, and "The Difficulty of Issuing Figures on Sand Cost Alloys," by W. M. Corse. The three papers are presented herewith in part.

The tentative specifications for non-ferrous alloys for railroad equipment, published on pages 284 and 285 of the July issue of THE FOUNDRY were referred back to the committee for further consideration, with instructions to report at the next annual meeting. Builders of locomotives objected to a number of the alloys specified, claiming that their adoption by the Society would greatly involve the testing of non-ferrous castings.

square inch. For example, on the 88-10-2 bronze results have been secured as high as 50,000 pounds per square inch on samples and as low as 25,000 pounds per square inch on others.

The size and design of the casting also have a marked influence on the results, so that it is very difficult to prepare either specifications or authentic information on the subject.

The committee's idea is to call attention to this fact and to urge work on the part of those interested that we may add to our experience tables sufficiently to enable us to publish authentic data. To the properties mentioned might be added such properties as linear co-efficient of expansion, electrical conductivity, thermal conductivity, specific gravity, weight per cubic inch, patternmaker's allowance for shrinkage, Brinell hardness, elastic limit or proportional limit under compression, and others that might be of special interest for certain work.

Tests of Castings

The committee also wishes to emphasize the importance of securing accurate tests from pieces cut from castings themselves, as this is really the information that the engineer desires. If buyers of castings will bear this point in mind the apparent discrepancy will gradually be cleared up as the publication of these results is increased. It is very seldom that extra castings are ordered for this purpose, but we do not see how authentic information regarding the properties of the metal actually in the casting can be obtained without such procedure.

The suggestion of using a standard shape test bar will certainly help a good deal, but even then there is always a question whether such a test bar will represent the casting itself.

Spelter---Its Grades and Uses

By G C Stone, W H Bassett and M N Price

SPELTER, like all commercial metals, contains impurities, but, unlike most other metals, none of these impurities are advantageous for any of the purposes for which it is used. The effects of these impurities on different products made from it vary greatly, hence the necessity for several grades differing in purity.

Spelter is used for the following purposes, in quantities in the order mentioned: Galvanizing, alloys, rolling, ornamental castings, and miscellaneous uses.

Spelter for Galvanizing

For ordinary galvanizing the effect of the common impurities is not very great. Iron is objectionable as causing a loss in dross and in making the coating more brittle and liable to crack and peel off. Lead, up to the limit found in commercial spelter, has no serious effect, but is objectionable when present in large quantities as it liquates in the bath and does not enter the coating and therefore, is wasted. Lead usually is worth less than zinc and the purchaser does not wish to pay for it at zinc prices.

The four higher grades of spelter are chiefly used for alloys and the specifications were principally made for the alloy makers and do not, in all cases, call for metal suitable for some of the other purposes for which it is used.

In alloys, aluminum is frequently very injurious, 0.01 per cent in many cases making brass useless for the purposes for which it is intended. In the few instances where its presence is desired, it is more satisfactory to add it directly than as a constituent of the spelter. The specifications, therefore, require that the four higher grades of spelter shall be entirely free from aluminum.

Iron is always present in spelter, but is very undesirable in brass and similar alloys, making them harder and greatly increasing the hardness due to cold working.

Lead is objectionable in some alloys and essential in others, and the main variation in the different grades of spelter is in the allowable amount of lead. High grade spelter, which is used for alloys that are to be subjected to the most severe spinning and drawing operations, can be rejected if it contains over 0.07 per cent of lead, as lead reduces the ductility of brass.

Intermediate spelter, with a lead limit of 0.20 per cent is used for alloys that do not have to undergo as severe treatment, and also very largely for alloys like manganese bronze that are used both cast and wrought.

Brass special has a lead limit of 0.60 per cent, and is mainly used for brasses where the maximum ductility is not required. The lead and iron are limited to 0.60 per cent and 0.03 per cent respectively, because brass made from such spelter is used for ordinary drawing, spinning, and forming work where the requirements are not especially severe.

Selected spelter carrying the maximum 0.80 per cent of lead and 0.04 per cent iron is used by brass manufacturers for making alloys to which lead is added in order to secure free cutting qualities. Material of this kind is usually made into rods and heavy sheets for the manufacture of small articles by turning, milling and drilling operations. Such brass must contain sufficient lead to reduce the strength of the material and cause the chips to break easily.

Owing to the fact that brass usually is made in crucibles in small quantities, uniformity in the spelter is of the greatest importance. As lead segregates badly, and more markedly the higher the proportion, the lead limit of the average sample is made low enough to allow for this tendency without injurious effect on the product. Even when the brass manufacturer adds lead, he does so in known amounts and thus obtains a uniform alloy from the different pots, which would not be possible if all the lead needed were contained in the spelter.

Cadmium

There is very little doubt but that cadmium in zinc is very injurious for some of the purposes for which it is used, as it renders it harder and much more brittle. There is, however, considerable difference of opinion as to how far these undesirable properties persist in alloys made from zinc containing cadmium. The majority of the brass makers are of the opinion that the high temperature of the brass pots cause so much of the cadmium to volatilize that the residual amount has very little deleterious effect.

There is no doubt but that large amounts of cadmium, say 1 or 2 per per cent, make brass hard and brittle. We have no reliable information at present showing the effect of small amounts of cadmium on the alloys, and the evidence on this point is extremely conflicting.

Cadmium, together with lead, seems to intensify the effect of the latter and also causes the brass to become more sensitive to the effect of overheating in the various annealing operations to which the wrought material is subjected.

Very little spelter is made containing as much cadmium as is allowed for intermediate and brass special and the specifications, therefore, put practically no limit on cadmium except for high

grade. Whatever the facts may be for alloys, it is certain that the amounts of cadmium allowed by the specifications are much greater than are permissible for other purposes for which zinc is used.

The question of cadmium in the better grades is complicated by the fact that until the last year and a half practically all the high grade and most of the intermediate spelter was made by one company from ores that are free from cadmium. The alloy makers, therefore, had no extended experience with the effect of cadmium in the better grades of spelter, and during the last 18 months conditions have been so abnormal that it is difficult to draw conclusions.

High grade spelter is extensively used for galvanizing telegraph and telephone wires which are required to stand sharp bending when making the lineman's splice, as it has been found that if impure spelter is used, the coating cracks and peels off the joint. The only high grade spelter that has been used for this purpose is entirely free from cadmium. Cadmium being the element most likely to cause this trouble, it is very doubtful whether metal containing as much as is allowed by the specifications (0.05 per ecnt) would be suitable for this purpose.

For rolling, cadmium causes such severe cracking that metal containing much of it is not economical; but as practically all the zinc rolling mills produce their own spelter, this matter is within their own control and the specifications do not affect them.

For ornamental castings no spelter described by the specifications would be satisfactory. The high grade is all right as far as lead and iron are concerned, but with the maximum cadmium allowed, it would be impossible to make castings of many of the common shapes.

A Review of the Tin Situation

By L Addicks and W A Cowan

A SPECIFICATION to be generally adopted must reasonably reconcile the inherently different points of view of producer and consumer. This requires a classification of the material which will allow the producer to market everything produced and the consumer to choose the grade suitable for his particular work, paying accordingly. It is obviously necessary to understand the situation from both sides when a specification is to be drawn up and this providing of a common ground is one of the chief functions of this society.

In the case of tin this mutual understanding is wholly lacking at the present time, due chiefly to the great geographical distance between the points of production and consumption and the speculative basis on which tin is handled by a broker as a middleman.

Practically speaking, there is but one ore of tin, cassiterite, which in some cases is almost pure stannic oxide. It occurs as *vein tin* in mineral lodes and as *stream tin* in alluvial deposits. Vein tin generally is associated with other minerals, while stream tin is much purer.

Tin is found in paying quantities in very few places. The relative importance of the sources may be judged by their approximate outputs, stated herewith in long tons of metallic tin per annum:

	Long Tons
Straits	60,000
Bolivia	20,000
Banka and Billiton	17,000
Cornwall	5,000
Australia	4,000
China	4,000
South Africa	2,500
Miscellaneous	2,500
	115,000

The Straits tin comes from Penang, Singapore and Malacca, the two latter being towns on the Malay peninsula and the former an island off the west coast and in English hands. Banka and Billiton are islands in the Dutch East Indies. The metallurgy of tin is very simple in the case of the pure deposits. The ores, which run but a few tenths of a per cent in tin, are readily concentrated by ordinary wet methods to a 60 to 70 per cent product, on account of the high specific gravity of cassiterite. The concentrate is smelted in a reverberatory furnace with coal as a reducing agent and the fluxes necessary to slag the remaining gangue. The resulting crude tin is then refined by liquating and drossing. As stannic oxide is difficult to reduce, the various impurities present are also reduced and largely collected in the crude tin from which they can be but imperfectly removed by liquation. The result is that the purity of the final product depends largely upon that of the original tin stone, certain deposits have come to have a reputation as producers of high grade tin. At this writing electrolytically refined tin is just beginning to appear on the market in quantity from the treatment of foul bullion produced in the usual way from Bolivian concentrates. Electrolysis, of course, should obliterate the past history of the crude tin.

It has been the fixed policy of the Dutch and English colonies to smelt the tin concentrates at the point of production, export duties having been imposed on tin ores. Prior to the war, the Bolivian concentrates were sent to England and Germany, where they were worked into a low grade tin. They are now coming chiefly to the United States and the crude tin obtained therefrom electrolytically refined as stated. Up to this time it has been impossible to buy the desirable Straits and Banka products which make up the bulk of the high grade output except upon reputation by brands, and the sales in America have been handled by brokers who are practically subject to the dictation of the Dutch-English ring controling those brands, in spite of the fact that this country consumes 45,000 tons a year, or over a third of the world's production. The recent importation of Bolivian concentrates and their local treatment, it is to be hoped, will alter this situation.

According to the rules of the London Metal Exchange, tin is merchant-

Table I.

ANALYSES OF DIFFERENT BRANDS OF TIN.

All Values in Per Cent.

Elements.	Electrolytic.[1]	Straits, Banka, Billiton.	Australian.	English common.	English refined.	German.	Chinese.	Bolivian.
					99.90	99+	95–99	93.0
Tin	99.80–99.95	99.80–99.95	99.75–99.90	99.20				
Antimony	....	0.02	0.04	0.25	0.04	0.65	0.02–0.40	4.0
Arsenic	....	0.04	0.06	0.06	0.05	....	0.06	0.2
Bismuth	....	none	0.003	0.06	0.001	....	0.01	0.1
Copper	....	0.01	0.04	0.08	0.015	....	0.09	0.5
Iron	....	0.03	0.03	0.004	0.002	....	0.15	0.02
Lead	....	0.02	0.04	0.36	0.01	0.14	0.3–4.0	2.7
Zinc	....	0.03	none	0.006	0.01	....	none	0.03

[1]Representative analyses of the new electrolytic tin are not available at this writing.

able as standard tin only when the warrant is accompanied by analysis certifying that the metal contains either 99 or 99.75 per cent of pure tin, according to whether the quality is that of common tin or refined tin, and also that it is of the correct physical condition.

Straits, Australian, English Refined, Banka and Billiton fall within the highest class, namely, refined tin. The Chinese tins are off-grade, carrying considerable lead, and the German tins resulting from the smelting of Bolivian concentrates are very foul. Off-grade tins are sold on the basis of a sliding scale for tin contents. The worst of them will run over 90 per cent tin, while the high grade tins will run 99.8 to 99.9 per cent. The only tests required for good merchantable tin aside from its origin are that it shall run at least 99.75 per cent tin and that a bar when nicked and bent double shall not crack.

The consumer has generally met the situation in which he finds himself by buying a first class brand, analyzing it when he gets it, and then sorting the lots by analysis for certain uses. It is of doubtful value to give here a long list of analyses of different brands, but a rough idea of the various grades given in Table I will illustrate the situation.
of a sliding scale for tin concentrates

The principal uses of tin, aside from tin salts and pigments, are as metal in pipe, fusible boiler plugs, etc.; as a coating, as in tin plate, tinned wire, tin-lead foil, etc.; and in an alloy, as in bronze, babbitt, solder, britannia metal, type metal, fusible alloys, etc. The bronzes are alloys with copper and zinc; babbitt metal with antimony and copper; solder with lead and a little antimony; britannia metal with antimony; fusible alloys with lead, bismuth and cadmium.

Allowable Impurities

The impurities in tin may cause trouble by poisoning, as in the case of pipe and tin cans; by impairing fluidity, causing an excessve consumption of tin used for coating, or making solder hard to apply; by fouling an alloy and spoiling its appearance; by impairing the ductility of alloys which have to be worked, such as bronze or britannia metal; by causing local galvanic action and possibly *tin pest* and by affecting the melting point of fusible alloys.

In a general way the purest obtainable tin is desired for pipe and boiler plugs. The United States bureau of standards has found that zinc, generally introduced by a foul pot when remelting tin, causes serious deterioration in boiler plugs and recommends, as nearly as possible, absolute freedom from zinc and lead.

One of the tin plate manufacturers states that lead makes a mottled finish, iron causes rough surface and impairs fluidity, and arsenic and zinc tend to form poisonous salts. They suggest maximum allowable percentages as follows:

	Per cent
Lead	0.04
Copper	0.02
Iron	0.05
Arsenic	0.05
Antimony	0.02
Zinc	0.05

One of the manufacturers of wrought bronze gives the following maximum allowable percentages:

	Per cent
Antimony	0.01
Bismuth	0.001
Lead	0.05
Iron	0.05

Acid Exceeded Basic Steel Castings in 1915

A TREMENDOUS increase in the production of acid open hearth steel castings in 1915 is shown by the figures compiled by the American Iron and Steel Institute. In 1909, 1910, 1912, 1913 and 1914 the production of basic open-hearth steel castings exceeded the output by the acid process and the reversal noted in 1915 is surprising to many steel foundrymen. It is claimed that steel castings entering into war materials are accountable for this increase in acid steel output, since the latter was specified in preference to basic in a large number of contracts. Abroad, acid steel is preferred to basic for casting purposes and the large export tonnage undoubtedly was the factor that again set basic steel to the rear.

In 1915 the production of acid open-hearth steel castings aggregated 402,229 tons, as compared with 333,103 tons by the basic open-hearth process. In 1909 basic steel castings first exceeded the output of acid, the tonnage of the former having been 306,005, as compared with 295,035 for the latter. In 1910 the production of basic was 433,976 tons and acid, 429,375 tons. In 1911 the acid steel casting output exceeded that of basic, with a total of 304,565 tons of acid and 266,626 tons of basic. In 1912 the basic steel casting production was 443,998 tons, as compared with 426,850 tons for acid; in 1913, basic 460,161 tons and acid, 450,055 tons and in 1914, basic, 334,144 tons and acid, 270,173 tons.

The total production of steel castings in 1915 was 866,824 tons, as compared with 693,246 tons in 1914. Last year's production, however, is exceeded by the totals of 1910, with 940,832 tons; 1912, with 966,621 tons and 1913, with 1,020,744 tons which stands as the high record. The production by the bessemer converter process in 1915 reached a total of 92,476 tons, which is a high mark by this method and is indicative of the widespread introduction of the side-blow furnace. The manufacture of castings by the crucible process aggregated 14,756 tons in 1915, as compared with 11,186 tons the previous year. The greatest proportionate increase, however, is shown by the electric steel casting output, with a total of 23,064 tons as compared with 8,551 tons the previous year. A complete record of the steel casting output from 1901 to 1915 is given in the accompanying table. The approximate production of alloy steel castings in 1915 was 97,896 tons by the different processes. This total is made up as follows: Basic open-hearth steel, 1,796 tons; acid open-hearth steel, 71,263 tons; bessemer steel, 23,900 tons; crucible steel, 841 tons and electric steel, 96 tons.

Production of Steel Castings

Year.	Open-hearth: Basic	Open-hearth: Acid	Open-hearth: Total	Bessemer	Crucible	Electric	Misc.	Total gross tons
1901	94,941	206,681	301,622	6,764	3,927	.....	5,257	317,570
1902	112,404	255,475	367,879	12,548	4,955	.....	5,553	390,935
1903	134,879	265,469	400,348	18,099	5,409	.....	6,409	430,265
1904	98,919	203,915	302,834	16,051	4,308	.....	7,018	330,211
1905	206,159	320,381	526,540	22,103	5,733	.....	6,391	560,767
1906	313,548	406,343	719,891	32,601	10,343	.....	10,870	773,705
1907	366,476	380,049	746,525	33,273	10,233	.....	13,086	803,117
1908	155,005	156,772	311,777	20,559	8,271	.....	5,613	346,220
1909	306,005	295,035	601,040	33,814	12,683	306	8,399	656,242
1910	433,976	429,375	863,351	58,335	14,632	1,320	3,194	940,832
1911	266,626	304,565	571,191	57,101	14,030	1,878	2,427	646,627
1912	443,998	426,850	870,848	68,750	20,550	4,162	2,311	966,621
1913	460,161	450,055	910,216	80,506	17,571	9,207	3,244	1,020,744
1914	334,144	270,173	604,317	65,882	11,186	8,551	3,310	693,246
1915	333,103	402,229	735,332	92,476	14,756	23,064	1,196	866,824

Number of Exhibitors Continues to Increase

Latest List of Manufacturers Who Will Display Their Equipment at Cleveland —Tentative Program of the Institute of Metals and Entertainment Features

ALTHOUGH the date of the opening of the exhibition of foundry equipment and supplies, and machine tools and accessories, to be held at Cleveland during the week of Sept. 11, is six weeks distant, 121 manufacturers already have reserved space and the indications are that 150 will be represented in the Coliseum and the temporary annex the morning the doors are opened to the public. It is estimated that the floor area to be occupied by the exhibits and the number of displays will exceed the Atlantic City show last year, by 50 per cent. The complete list of exhibitors to July 26, follows:

Amalgamated Machinery Corporation, Chicago.
American Gum Products Co., New York.
American Hoist & Derrick Co., Minneapolis.
Arcade Mfg. Co., Freeport, Ill.
Armstrong Cork Co., Pittsburgh.
Atkins, E. C., & Co., Indianapolis.
Ayer & Lord Tie Co., Chicago.
B. & B. Manufacturing Co., Indianapolis.
Berkshire Mfg. Co., Cleveland.
Besly, Chas. H., & Co., Chicago.
Birkenstein, S., & Sons, Chicago.
Blystone Mfg. Co., Cambridge Springs, Pa.
Brass World Publishing Co., New York.
Brown Hoisting Machinery Co., Cleveland.
Brown Specialty Machinery Co., Chicago.
Carborundum Co., Niagara Falls, N. Y.
Cataract Refining & Mfg. Co., Buffalo.
Chicago Pneumatic Tool Co., Chicago.
Cincinnati Pulley Machinery Co., Cincinnati.
Cleveland Blow Pipe & Mfg. Co., Cleveland.
Cleveland Pneumatic Tool Co., Cleveland.
Cleveland Wire Spring Co., Cleveland.
Coale, Thomas E., Lumber Co., Philadelphia.
Curtis Pneumatic Machinery Co., St. Louis.
Delton Adding Machine Co., Cincinnati.
Davis Bournonville Co., Jersey City, N. J.
Dixon, Joseph, Crucible Co., Jersey City, N. J.
Electric Controller & Mfg. Co., Cleveland.
Excelsior Tool & Machine Co., E. St. Louis, Ill.
Federal Foundry Supply Co., Cleveland.
Felt & Tarrant Mfg. Co., Chicago.
THE FOUNDRY, Cleveland.
Gardner Machine Co., Beloit, Wis.
General Electric Co., Schenectady, N. Y.
Gibb Instrument Co., Pittsburgh.
Gisholt Machine Co., Madison, Wis.
Goldschmidt Thermit Co., New York.
Gordon Sand Co., Conneaut, O.
Graceton Coke Co., Graceton, Pa.
Great Western Mfg. Co., Leavenworth, Kas.
Hardy, F. A., & Co., Chicago.
Harris, Benjamin, & Co., Chicago.
Hauck Mfg. Co., Brooklyn, N. Y.
Hayward Co., New York.
Herman Pneumatic Machine Co., Pittsburgh.
Herold Bros. Co., Cleveland.
Hill-Brunner Foundry Supply Co., Cincinnati.
Hill & Griffith Co., Cincinnati.
Hoevel Mfg. Corporation, New York.
Ingersoll-Rand Co., New York.
International Molding Machine Co., Chicago.
Interstate Sand Co., Zanesville, O.
Iron Age, New York.
THE IRON TRADE REVIEW, Cleveland.
Jennison-Wright Co., Toledo, O.
Chas. C. Kawin Co. Chicago.
Julius King Optical Co., New York.
Lees Bradner Co., Cleveland.
Lehigh Coke Co., South Bethlehem, Pa.
Life Saving Devices Co., Chicago.
Lincoln Electric Co., Cleveland.
Lucas Machine Tool Co., Cleveland.
Lupton's David, Sons Co., Philadelphia.
McCormick, J. S., Co., Pittsburgh.
MacLean Publishing Co., Toronto, Ont.
Macleod Co., Cincinnati.
Mahr Mfg. Co., Minneapolis.
Malleable Iron Fittings Co., Branford, Conn.
Manitowoc Electric Implement Co., Manitowoc, Wis.
Metal Industry, New York.
Michigan Smelting & Refining Co., Detroit.
Midland Machine Co., Detroit.
Moldar Co., Maspeth, N. Y.
Moltrup Steel Products Co., Beaver Falls, Pa.
Monarch Engineering & Mfg. Co., Baltimore.
Motch & Merryweather Machinery Co., Cleveland.
Mott Sand Blast Mfg. Co., Chicago.
Multi-Metal Separating Screen Co., New York.
Mumford, E. H., Co., Elizabeth, N. J.
Mumford Molding Machine Co., Chicago.
National Engineering Co., Chicago.
New Haven Sand Blast Co., New Haven, Conn.
Norma Co. of America, New York.
Norton Co., Worcester, Mass.
Obermayer, S., Co., Chicago.
Oliver Machinery Co., Grand Rapids, Mich.
Osborn Mfg. Co., Cleveland.
Oxweld Acetylene Co., Chicago.
Pangborn Corporation, Hagerstown, Md.
Pickands, Brown & Co., Chicago.
Pittsburgh Crushed Steel Co., Pittsburgh.
Portage Silica Co., Youngstown, O.
Pridmore, Henry E., Chicago.
Pyrotectite Co., Chicago.
Robeson Process Co., New York.
Rogers, Brown & Co., Cincinnati.
Sand Mixing Machine Co., New York.
Sly, W. W., Mfg. Co., Cleveland.
Smith, Werner G., Co., Cleveland.
Smith Facing & Supply Co., Cleveland.
Smith, R. P., & Sons Co., Chicago.
Snyder Electric Furnace Co., Chicago.
Standard Sand & Machine Co., Cleveland.
Sterling Wheelbarrow Co., West Allis, Wis.
Stevens, Frederic B., Detroit.
Strong-Kennard & Nutt Co., Cleveland.
Sullivan Machinery Co., Chicago.
Superior Sand Co., Cleveland.
Thomas Elevator Co., Chicago.
Titanium Alloy Mfg. Co., Niagara Falls, N. Y.
Union Steam Pump Co., Battle Creek, Mich.
U. S. Graphite Co., Saginaw, Mich.
U. S. Molding Machine Co., Cleveland.
United States Silica Co., Chicago.
Wadsworth Core Machine & Equipment Co., Akron, O.
J. D. Wallace, Chicago.
Warner & Swasey Co., Cleveland.
West Haven Mfg. Co., New Haven, Conn.
Wheeler & Holcomb, Chicago.
White & Bros., Inc., Philadelphia.
Whiting Foundry Equipment Co., Harvey, Ill.
Woodison, E. J., Co., Detroit.

Tentative Program

The convention of the American Institute of Metals will be held concurrent with the exhibition and the annual meeting of the American Foundrymen's Association. The tentative program, presented herewith, is replete with topics of interest to producers of non-ferrous metal and alloy castings:

"Reclamation of Metallics from the By-Products of Foundry and Manufacturing Plants," by A. F. Taggart, Hammond Laboratory, Yale University, New Haven, Conn.

"Method of Selling Non-Ferrous Scrap, as Pursued by a Large Producer," by J. M. Bateman, Western Electric Co., Chicago.

"The Result of Joint Work of Casting and Testing the 88-10-2 Alloy by five Foundries," "Report of the Use of the Deoxidizers of Bronzes," and "Report on the Aspects of Bronze Failures," by various experts affiliated with the U. S. Bureau of Standards, Washington, D. C.

"Copper-Aluminum-Iron Alloys," by W. M. Corse, Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

"Tests on Rolled Brass Sheets Taken in the Direction of Rolling and at right Angles to the Directions," by W. B. Price and P. H. Davidson, Scovill Mfg. Co., Waterbury, Conn.

"The Application of the Oxy-Acetylene Welding Process in the Repair of Defective Non-Ferrous Castings," by S. W. Miller, Rochester Welding Co., Rochester, N. Y.

"Continuation of Discussion in Connection With Defective Bronze Castings in Use by the Board of Water Supply of New York City," by A. D. Flinn, Board of Water Supply, New York.

"Evolution of the Die Casting Process," by Chas. Pack, Doehler Die Casting Co., Brooklyn, N. Y.

"Disclosure of Blow-Holes by Means of X-Ray Apparatus," to be reported by testing engineers employed in laboratory D of the General Electric Co., Schenectady, N. Y.

"Aluminum Castings and Forgings," by P. E. McKinney, U. S. Navy Yard, Washington, D. C.

"Annealing Properties of Copper," by G. W. Ceaser and G. C. Gerner, Hammond Laboratory, Yale University, New Haven, Conn.

"Metallography as Applied to Non-Ferrous Metals," by W. W. Arthur, Frankford Arsenal, Frankford, Philadelphia.

"Heat-Treatment of German Silver," by G. C. Holder, American Optical Co.

S. D. Sleeth of the Westinghouse Air Brake Co., Wilmerding, Pa., and Mr. Barnes of the Ft. Wayne Electric Co., Ft. Wayne, Ind., will present papers at the session to be devoted exclusively to the discussion of brass foundry practice and papers also will be ready by F. L. Antisell, Raritan Copper Works, Perth Amboy, N. J., and by Mr. Bragg, Ohio Brass Co., Mansfield, O.

Entertainment Features

The Cleveland local committee has held several meetings during the month and an elaborate entertainment program has been outlined. This will include tickets to an American League ball game, Cleveland versus Detroit; a night

(*Continued on page* 331.)

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Cleveland Calls

NEVER before in the history of the organization movement among foundrymen have the prospects been brighter than this year for a record-breaking attendance at the annual meetings of the American Foundrymen's Association and the American Institute of Metals, and the exhibition of foundry supplies and equipment, which will be held at Cleveland during the week of Sept. 11. The technical programs arranged by these two societies touch upon every phase of foundry practice, and every casting manufacturer should arrange his affairs during Founders' week to permit the attendance of his plant executives at the technical sessions, at least a part of the week, if his force cannot be spared for the entire period. The one meeting per day plan to be inaugurated this year, it is believed, will afford the visitors greater opportunity for the inspection of the exhibits and plant visitation. The overwhelming success of the exhibition is assured. So great is the demand for space that it is necessary to erect a temporary building to take care of the overflow. Cleveland calls, therefore mark the week of Sept. 11 on your calendar.

Trade Outlook

A SLIGHT improvement in labor conditions is noted in the foundry industry. Unskilled men are not quite so arbitrary in their demands and it seems that the maximum in wages and the minimum in working hours have been satisfactorily established, for the present at least. The hysterical cry for *help* set up by manufacturers shortly after the first of the year is not quite so shrill and labor already has detected a marked softening of the tone. The off-season in the automobile trade undoubtedly is a contributing factor in bringing about this condition and munition plants have released many men. The lessened pressure by common labor in the foundries reflects an increase in the available supply, although this is still insufficient to meet the needs of casting manufacturers. During the last three months, the melt of the gray and malleable iron foundries and the output of the steel casting shops have been considerably curtailed by the shortage of labor and this decline in consumption is beginning to affect the iron market. Purchases of raw material were made six months ago on a large scale to cover the tremendous tonnage of casting contracts placed with the foundries, and if their output could have maintained pace with the specified deliveries, they now would be crowding the blast furnaces for iron. In the yards of many plants, pig metal has accumulated so fast that orders have been issued to hold up shipments temporarily. While a slight softening of the foundry iron situation is noticeable, prices are being fairly well maintained. The unfilled tonnage on the books of the iron producers will carry them well through the fourth quarter of the year and a capacity melt will soon move the accumulated stocks in foundry yards. In the leading centers, foundry grades of pig iron are quoted as follows: No. 2, Chicago, $19; Cleveland, $18.80; Buffalo, $18.25; Birmingham, $14; Pittsburgh, $19.45, and Philadelphia, $19.25. Malleable iron is firm at $19.50, Chicago; $18.50, Buffalo, and $21, Philadelphia. At Pittsburgh the price of basic is $18.95 and at Philadelphia, $19; charcoal iron is unchanged, grades of Lake Superior, Nos. 1 to 4, being held at $19.75 to $22.25, Chicago.

Annual Conference of British Foundrymen

On account of the war, the annual conference of the British Foundrymen's Association was limited to the election of officers. One session only was held in the Connaught rooms, London, on the afternoon of June 24. J. Ellis, of Luton, was elected president; T. H. Firth, Sheffield, senior vice president, and J. Little, Sheffield, junior vice president. Mr. Little is president of the Sheffield branch of the British Foundrymen's Association and is manager of Cammell Laird & Co. W. Finch was re-elected treasurer. Retiring President Mayer presented the association with a magnificent gold medallion and chain to be worn by future presidents as an insignia of office. Each of the past presidents has a separate link in the chain recording the period of his presidency. An illuminated address in book form was presented to Sidney Gimson, of Leicester, one of the past presidents of the association.

Personal

F. C. Hinkey, formerly affiliated with the East St. Louis, Ill., plant of the American Steel Foundries, is now superintendent of the Thurlow plant of this company, Thurlow, Pa.

George Rhins, formerly general superintendent of Stanley G. Flagg & Co., Stowe, Pa., has been elected secretary of the Allith-Prouty Co., Danville, Ill., manufacturer of gray iron hardware specialties.

Gilbert T. Mason, formerly secretary and treasurer of the Atkinson Co., Rochester, N. Y., now is affiliated with the sales force of the bronze department of the Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

H. V. Adam, of the Randoe-Goenting sugar works, Djocjakarta, Java, Dutch East Indies, is in this country to purchase equipment for a new foundry he will establish in Java. He is staying at the Hotel Chelsea, New York.

Crowley Electric Steel Plant to be Enlarged

A banquet commemorating the first anniversary of the pouring of the initial heat from the Gronwall-Dixon electric steel melting furnace installed by the John A. Crowley Co., Detroit, was given on July 22 at the Detroit Athletic Club. The dinner was attended by the executives of the engineering, laboratory, metallurgical, operating, sales and clerical departments of the Crowley company. During the year more than 5,000 tons of chrome vanadium, nickel chrome, nickel and other high grade steels have been refined in this furnace. A modern plant now is being completed in Detroit in which several electric furnaces are being installed, that will have an annual output of 30,000 tons of electric steel.

Individuality in Advertising

"That and This," and a little of the other thing, have been assembled into a 56-page booklet issued by Frederic B. Stevens, Detroit. The author is frank in stating that it is not a summer idyl, but a sequel to "This and That," another booklet from Mr. Stevens' pen issued some months ago. As a piece of trade literature, this work

J. ELLIS
President, British Foundrymen's Association

is unique, every page bearing the stamp of the Stevens' individuality. When not otherwise engaged, Frederic B. manufactures foundry facings, foundry supplies, buffing compositions and electro-platers' supplies.

Number of Exhibitors Continues to Increase

(*Continued from page 329.*)

at Euclid Beach, a theater party, inspection of the Cleveland Furnace Co.'s plant and the annual banquet at which Irving Bacheller, the noted humorist, will be one of the speakers. The ladies will share in all of the entertainments outlined, and in addition will be given a luncheon at one of the Country clubs and an automobile ride over Cleveland's magnificent park system. Practically all of the golf links in and adjacent to the Forest City will be available to the devotees of this sport and plant visitation has been arranged for Thursday and Friday of convention week.

A New Safety Code for Foundries Drafted

A new safety code for iron, steel and brass foundries was drafted at a meeting of the Committee on Safety and Sanitation of the American Foundrymen's Association held at Rochester, N. Y., Thursday and Friday, July 20 and 21. This code will be presented for adoption at the annual convention of this organization, to be held at Cleveland during the week of Sept 11. It is believed that the new code, which embodies the best features of a number of the state codes as well as those of a code adopted by another association, can be used as a guide for safety rules to be passed by various states. Furthermore, it is altogether probable that if this code is accepted by the members of the American Foundrymen's Association, the codes of several states, already in effect, will be changed to conform with that of this society. Victor T. Noonan, of the Industrial Commission of Ohio, is chairman of the Committee on Safety and Sanitation, and other members who attended this meeting included F. H. Elam, American Steel Foundries, Chicago; George B. Koch, Pennsylvania Railroad Co., Altoona, Pa.; E. B. Morgan, Norton Co., Worcester, Mass.; Ralph H. West, West Steel Casting Co., Cleveland; Dr. Richard Moldenke, Watchung, N. J., and Thomas J. Soults, Sill Stove Works, Rochester, N. Y.

Book Review

Mechanical Engineers' Handbook, edited by Lionel S. Marks; leather; 1,836 pages, 4½ x 7 inches; published by McGraw-Hill Book Co., and furnished by THE FOUNDRY for $5 net.

In the *Mechanical Engineers' Handbook*, the editor, Lionel S. Marks, professor of mechanical engineering, Massachusetts Institute of Technology, has brought together in one volume the work of some 50 specialists, whose names are linked with much that has been written on engineering subjects in this country. In many respects the book is patterned after the *Hutte*, a three-volume German book containing data contributed by a number of mechanical engineers.

The arrangement of the subject matter is much the same as that of other American hand books, mathematics, mechanics, strength of materials, etc., preceding the information relative to the practical application of the theory. Although the book seems to contain a great amount of data assembled in tabular form, it is evident that the author has preferred the text-book style of presenting information. Consequently each subject is introduced with definitions

and descriptions of fundamentals, after which comes classification and elaboration of the subject. To assist in grasping at a glance the important parts of paragraphs, catch words which indicate the subject are printed in black-face type. The book is provided with two detailed indices, one of which lists the subjects in the order they appear in the book. The other, which fills over 50 pages, contains an alphabetical list of the contents. As a further help, the book is divided into sections, which are marked by means of thumb tabs. A key to these tabs appears on the inside and facing pages of the front and back cover, enabling the reader to turn to any major topic almost instantly.

The editing of the vast amount of information contained in the 1,800 pages seems to have been done with a view of sifting out all but important details, but this policy of elimination has not been carried to the point where any subject has suffered from the treatment. In general, considering the fact that the book is in its first edition, it may be said that the authors, co-operating under the leadership of the editor-in-chief have succeeded in establishing a valuable fund of information, which should improve as later editions are published.

Casting Rims and Hubs on Sheaves

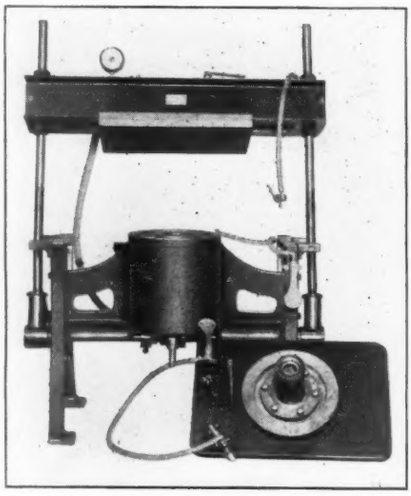
By W. J. Keep

Question:—For a number of years we have been making 10-foot sheaves, of the bicycle type, with split hubs. Recently we have been trying to make them with solid hubs and have experienced trouble in keeping the rims straight. To hold the rims in line, we leave the weights on the flasks until after the hubs are cast, with the result that the spokes break in two. We cast the rim one day and the hub on the following day. Will you kindly suggest a remedy?

Answer:—Before replying to your inquiry it might be well to inquire whether the spokes are exposed to the air when the hub is cast? It might be advisable to make a flask for the rim only, the spokes passing through the inside wall of the flask, thereby exposing the greater part of each spoke to the air. The inner ends of the spokes would pass into a small flask at the center, in which the hub would be molded. The rim should be poured one day, and on the following day the hub should be cast. If the air will not keep the spokes cool, try cooling them with water. If this suggestion does not effect a remedy, it is altogether possible that some readers of THE FOUNDRY may be able to suggest something more satisfactory.

A Combination Squeeze and Jolt Machine

In the accompanying illustration is shown a combination jolt-ramming and squeezer molding machine built by the Federal Foundry Supply Co., Cleveland, which is particularly adapted for deep work or patterns having pockets or projecting lugs, as it eliminates tucking and prevents ram-offs. The machine is built in two sizes, one having 9-inch squeezing and 3½-inch jolting cylinders with a distance between the rods of 30 inches, and the other has 12-inch squeezing and 4-inch jolting cylinders, with a distance between the rods of 40 inches. The machine is fully equipped with a blow-cock, knee valve and vibrator, and also is provided with a gage and blow-off attachment to permit of setting the machine for any desired squeezing pressure. The accompanying illustration shows the table lifted from the cylinders, illustrating the simplicity of construction.



COMBINATION JOLT-RAMMING AND SQUEEZER MOLDING MACHINE

New Plant to be Built

The Werner G. Smith Co., Cleveland, manufacturer of a liquid core binder, now located at Hird street and the Nickel Plate railroad, has purchased a site for the erection of a new plant on West 110th street, near Madison avenue. Owing to the big increase in the demand for this company's product, the erection of a plant of much larger capacity than its present works has become necessary.

Herbert G. Cannon has established an office at 1035 Williamson building, Cleveland, as consulting mining engineer. He is a graduate of the Columbia School of Mines and formerly was associated with the Cleveland Cliffs Iron Co., Ishpeming, Mich.; Goldfield Consolidated Mines Co., Goldfield, Nev.; Stone & Webster, Boston, and B. B. Lawrence, consulting mining engineer, New York City.

Moisture in the Cupola Lining

A large gray iron foundry located on the bank of the river, surrounded by hills on either side, recently made a change in the personnel of its supervision and one of the first problems with which the new superintendent was confronted was dull iron during the first part of the heat. The size of the bed was increased and other methods were resorted to for the purpose of insuring hot iron, but regardless of all of the efforts made, the first iron tapped invariably was cold. Owing to the wear on the lining, it was decided to reline to the charging door and in order to dry out the cupola blocks thoroughly, a hot fire was built in the furnace which resulted not only in drying out the lining, but also in insuring hot iron during the first part of the heat. The next morning the superintendent casually inspected the lining and was surprised to note that the brickwork had absorbed moisture for a considerable distance from the bottom and he concluded that the weather conditions in his immediate vicinity were at fault and were the cause of the dull iron during the first part of the heat. As a result of this discovery a hot fire is lighted in the cupola at least 30 minutes earlier than heretofore, which drives the moisture out of the lining and no further difficulty is experienced with dull iron during the first part of the heat.

Pointers on Cupola Operations

By W. J. Keep

Question:—Referring to several of your recent articles on "Dull Iron", published in THE FOUNDRY, I would like to know why it is better to use the bottom row of tuyeres only, than both top and bottom rows. Is a height of 15 inches above the tuyeres about correct for the coke bed? I have always understood it to be 18 to 24 inches. If two rows of tuyeres were used, would it make any difference in the height of the bed? Should the air pressure for two rows of tuyeres be the same as for one? What are the limits in weight and dimensions of pig iron and scrap that should be charged in a 60-inch cupola? I understand there is a certain zone in the cupola where melting conditions are ideal. If the bed is too low, and also too high, what effect does it have on the speed of melting and the temperature of the iron?

Answer:—Since you are located in the east, it is altogether probable that

you are using anthracite coal for a portion of your fuel charge. All my comments were based on melting with coke. The coke bed should extend to a height not less than 15 inches above the upper row of tuyeres. If your heats are very large, you might melt faster with two rows of tuyeres, but by enlarging the lower row to deliver all of the air that is required, you should be able to melt just as fast. A number of good arguments can be advanced in favor of the upper row of tuyeres. An excess of air generates carbonic acid gas which is ignited by the air from the upper row and increases the temperature. While this is true, nevertheless the same conditions prevail above the second row of tuyeres. Practically all modern cupolas are built with two rows of tuyeres and the upper row can be closed off if desired. Operating with two rows of tuyeres will require a greater charge of coke on the bed, and at the end of the heat, the air introduced through the upper row has a tendency to chill the last charge of iron. Melting occurs at a height of from 13 to 24 inches above the tuyeres. If 9 pounds of iron can be melted with each pound of coke, and if you charge two pounds of coke for the same amount of iron, the iron naturally will be very hot, but melting will be slow because time is required to burn up the extra amount of fuel.

If you now are melting hot iron, to increase the speed of melting, reduce the coke charges as much as possible without obtaining dull iron. The air pressure with two rows of tuyeres is the same as with one row, provided the size of the tuyeres in each case is the same.

The depth of the metal charges should be about 4 inches, or the thickness of a pig. The scrap should be broken as small as the pig iron. The proportions between the scrap and the pig charged will depend upon the class of work produced. A stove foundry will make 40 per cent of scrap and light hardware shops will run as high as 50 per cent. On the other hand, in shops specializing in machinery castings the losses will be less than 25 per cent and outside scrap will have to be purchased.

While the United States ranks as one of the smallest producers of platinum, the output in 1915 in California and Oregon totaled 742 troy ounces, valued at $23,538, an increase of 172 ounces over the production of 1914.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Lakeside Foundry Co., Muskegon, Mich., will erect a plant, 75 x 225 feet.

William Bartley & Sons, Bartley, N. J., will build a two-story foundry, 27 x 84 feet.

F. C. Lane, 1117 Prairie avenue, Houston, Texas, will erect a brass foundry.

The Love Iron Foundry Co., Winchester, Ky., will move its business to Lexington, Ky.

A contract has been let for the construction of a $40,000 malleable foundry at Canton, O., for the Timken-Detroit Axle Co.

The Western Crucible Steel Casting Co., Minneapolis, contemplates the erection of an addition at a cost of $50,000.

The Blackwood Foundry Co., Blackwood, N. J., is building a 50 x 60-foot addition to its plant.

The Alberta Foundry & Machine Co., Medicine Hat, Alberta, Can., will erect an iron foundry and machine shop at a cost of $20,000.

The Texas Iron Metal Co., Dallas, Texas, contemplates building a foundry at a cost of $15,000.

The La Porte Furnace & Foundry Co., La Porte, Ind., is erecting a foundry, 50 x 200 feet, at a cost of $8,000.

The Duluth Brass Works, Duluth, will build an addition to its foundry, 50 x 80 feet, at a cost of $8,000.

Plans are being prepared for extensive additions to the plant of the Canton Foundry & Machine Co., Canton, O.

The Buffalo Foundry & Machine Co., Buffalo, will build a 100 x 116-foot machine shop at a cost of $40,000.

J. E. Lee, Ross Lee and J. F. Green, of Springfield, Mo., will erect a foundry and machine shop at Yellville, Ark.

A contract has been awarded for the erection of a 100 x 112-foot casting shop for the Raritan Copper Works, Perth Amboy, N. J.

F. L. Schmidth & Co., Elizabeth, N. J., will build a foundry, 108 x 49 feet, with a wing, 25 x 49 feet, at a cost of $16,000.

The Bond Foundry & Machine Co., Manheim, Pa., will build an addition to its plant, 95 x 100 feet.

The Western Crucible Steel Casting Co., Minneapolis, will make additions to its plant at an estimated cost of $50,000.

The Adamson Co., East Palestine, O., is erecting a three-story plant which will include gray iron and brass foundries.

The Moline Malleable Iron Co., Moline, Ill., has increased its capital stock from $75,000 to $100,000.

S. Dougherty, of Beaumont, Tex., will establish a brass foundry and machine shop at Tulsa, Okla.

The Motor Castings Co., 710 Hart avenue, Detroit, has been organized to succeed the Motor Foundry Co.

The Lakeside Foundry Co., Detroit, has increased its capital stock from $40,000 to $120,000.

The Alloy Die Casting Co., Detroit, has been incorporated by Henry Hensler, Ralph Johnson and F. P. Minckler.

The Argenta Foundry Co., Argenta, Ark., recently incorporated, has started the manufacture of sash weights.

Harris Bros., Chicago, have purchased the Huntington Machine & Foundry Co., Huntington, Ind.

The Cooper Foundry Co., Atchison, Kas., recently organized with Charles Cooper as president, will build a plant, 48 x 60 feet.

The Ashland Foundry Co., Ashland, O., has increased its capital stock from $32,000 to $40,000.

The H. J. Frank Foundry & Machine Co., Davenport, Ia., will erect a branch plant at Moline, Ill., which will include a foundry, forge and machine shops.

Plans are being prepared by Carl Barkhausen, architect, Milwaukee, for a foundry costing $5,000 to be erected at Sixty-third avenue and Burnham street, West Allis, Wis.

The Barnes Foundry Co., Jersey City, has been incorporated with a capital stock of $25,000 by E. D. Bolton, T. B. Moran and J. E. Donahue.

Bids are being received by Deutsch & Pollis, 50 Church street, New York City, for a 100 x 108-foot foundry to be erected at Farmingdale, L. I., N. Y.

A contract has been awarded by the American Locomotive Co., Schenectady, N. Y., for the erection of foundry additions, 100 x 175, 55 x 200 and 55 x 200 feet.

The Supplee-Biddle Hardware Co., Philadelphia, has leased an idle foundry at Palmyra, N. J., which will be remodeled and placed in operation in the near future.

The T. A. Cummings Foundry Co., 1338 Clybourn place, Chicago, will erect a brick and steel, foundry addition, 75 x 100 feet, at a cost of $10,000.

The Chippewa Foundry & Machine Co., Chippewa Falls, Wis., has been reorganized with $100,000 capital and will erect a casting plant.

The Benton Harbor Malleable Foundry Co., Benton Harbor, Mich., will build an addition to its pattern shop and foundry at a cost of $5,000.

Work will be started shortly on a $15,000 brick and steel addition to the plant of the National Bronze & Aluminum Co., 2539 East Seventy-ninth street, Cleveland.

A contract has been let for the erection of a $35,000 foundry and machine shop for the Cortland Foundry & Machine Co., Cortland, N. Y.

The Blackwood Foundry Co., Blackwood, N. J., is erecting an addition to its plant, 50 x 60 feet, and a carpenter shop 14 x 16 feet also is being built.

The Manufacturers' Brass Foundry Co., Detroit, has been incorporated with $3,000 capital, by G. J. Rinke, Richard Agricola and L. C. Vecelius.

The Pacific Foundry & Machinery Co., Seattle, Wash., has been incorporated with

a capital stock of $500,000 by J. L. McDonald, H. S. Hendrickson and Frank S. Paul.

The Massachusetts Copper Casting Co., Boston, has been incorporated with $10,000 capital by M. E. Thomas, M. B. Wilson and R. J. Holmes.

The Mohawk Valley Pipe & Foundry Co., Utica, N. Y., has been incorporated with a capital stock of $300,000, by A. B. Maynard, J. Rothstein and J. A. Gunn.

J. W. Radford, Joseph Fetter and E. W. Brown have purchased the foundry and machine shop of Castor & Son, Owosso, Mich., an will continue to operate the plant.

The Joubert & Goslin Machine & Foundry Co., Birmingham, has been incorporated with $275,000 capital to take over the plant of the Payne & Joubert Co., New Orleans, La.

The Decatur Malleable Iron Co., Decatur, Ill., has been incorporated with a capital stock of $2,500 by M. B. Rutherford, C. E. Yocam and J. R. Peterson.

The Specialty Castings Co., Dayton, O., has been incorporated by George C. Blenner, Christina Blenner, John J. Hockey, Elizabeth Hockey and Sam Nonnemann.

A foundry addition, 47 x 410 feet, which will cost $75,000 exclusive of the cost of equipment, will be erected by the Great Western Smelting & Refining Co., 600 West Forty-first street, Chicago.

The Alex Kilpatrick & Sons Foundry Co., St. Louis, will erect a plant in North St. Louis on a large tract of land which it recently acquired. The present foundry at 625 Carrie avenue will continue in operation.

The Herschfield-Piper Foundry & Machine Co., Chicago, has been incorporated with a capital stock of $75,000 by R. L. Wenstrand, J. E. Lee and Joseph Solari, 332 South Michigan avenue.

The Continental Gin Co., Bridgewater, Mass., has erected an office building in connection with its plant, the headquarters having been removed to this office from the downtown section of Bridgewater.

The Lightning Machinery Co., Oklahoma City, Okla., has been incorporated with $15,000 capital to operate a foundry and machine shop. The incorporators are Edward Goodwin, George Pladger and H. H. Hinkle.

The French Creek Foundry Co., Franklin, Pa., has been incorporated with a capital stock of $25,000 by Robert Ramsey, Robert Carnick, F. L. Liddle, August S. Karns and R. R. Bleakley.

The Union Steel Casting Co., Boston, whose plant was destroyed by fire on June 10, has leased the foundries of the G. W. & F. Smith Iron Works, in the Roxbury district, Boston, which have sufficient capacity to supply all the needs of the Union Steel Casting Co.'s trade.

H. D. Kramm, formerly affiliated with the Pioneer Brass Works, Indianapolis, Ind., is incorporating a company for the manufacture of aluminum castings and pistons. Offices will be maintained at 917 Fletcher Trust building, Indianapolis, until the plant is completed.

The London Gas Power Co., London, Ont., Can., has been incorporated with $100,000 capital stock to engage in the manufacture of iron and brass castings, steel, etc. W. H. Heard, J. W. G. Winnett and C. A. Bowman are the incorporators.

The Gier & Dail Mfg. Co., Lansing, Mich., manufacturer of light and heavy stampings and automobile parts, has increased its capital stock from $100,000 to $500,000, which will be used for the erection of a foundry and the purchase of additional equipment.

The Wetzel Machanical Stoker Co., Port Jefferson, N. Y., has been incorporated to engage in the manufacture of hardware specialties and to operate a foundry. The company is capitalized at $50,000 and has been incorporated by T. M. McGrath, C. S. Yawger and F. C. Williams.

The Henry Perkins Co., Bridgewater, Mass., which operates a gray iron foundry for the manufacture of castings for wire nail machines, piano plates, etc., is installing a cupola, charging floor elevator and a number of molding machines. The plant also is being electrically-equipped throughout.

The Superior Foundry Co., Holland, Mich., has been incorporated with a capital stock of $50,000 to engage in the manufacture of gray iron castings, specializing in castings for gas engines. The officers are George E. Kollen, president; John Glupker, vice president, and A. Knoorihnizen, secretary, treasurer and manager.

The Plymouth Motor Castings Co., Plymouth, Mich., has been organized with $75,000,000 capital to engage in the manufacture of gray iron and semi-steel castings. A plant owned by the Plymouth Improvement Association has been obtained by this company and an addition, 90 x 30 feet will be erected immediately. N. E. Sherwood, 703 Gas building, Detroit, is president; J. Fitzgerald, vice president; J. W. Furman, 1036 Majestic building, Detroit, secretary, and James B. Hickey, treasurer and production manager.

NEW TRADE PUBLICATIONS

DRILLS.—An 8-page folder, devoted to machine tool controllers, has been issued by the Cutler-Hammer Mfg. Co., Milwaukee. Three classes of controllers are described, including those designed for plain starting, speed setting and speed regulating.

TRAVELING CRANES. — The Shepard Crane & Hoist Co., Montour Falls, N. Y., has issued a bulletin describing the crane equipment in the new laboratories of the Massachusetts Institute of Technology. The pamphlet contains a panorama of the new buildings and illustrations of the hydraulic, steam and electric laboratories which are equipped with Shepard cranes.

SNAP FLASKS. — A comprehensive catalog devoted to snap flasks, slip jackets, steel bands, flask hinges, flask clamps, rapping plates, core boxes, etc., has been issued by the Diamond Clamp & Flask Co., Richmond, Ind. A special flask is shown which is particularly adapted to squeezer work. Special flasks are illustrated and described, including tapered flasks with regular parting lines, round flasks, etc.

COAL AND ASH GATES. — The C. W. Hunt Co., West New Brighton, N. Y., has issued a catalog which describes the several types of cut-off valves it manufactures. Views and dimensions of the standard types are presented together with suggestions covering the uses to which each type is adapted. The C. W. Hunt Co. designs and constructs valves and slide gates for special requirements. This company has the exclusive agency for the MacDonald-Mann quenching chutes.

ELECTRIC HOISTS.—The Sprague Electric Works of the General Electric Co., New York, has published a catalog devoted to its one-half and 1-ton electric hoists and the many applications for which they are adapted are considered. In addition to descriptions of the various parts of the hoist and their individual functions, a detailed drawing is included showing the size and space occupied by the different types. The hoists are built to operate on either alternating or direct current.

ABRASIVES.—A well-illustrated, 162-page catalog, devoted to its extensive line of grinding wheels, sharpening stones, refractories, wheel dressers, grinding machinery, etc., has been issued by the Norton Co., Worcester, Mass. Views of the company's mines and plants constitute the opening section, which is followed with price lists and dimensions of wheels for various grinding machines. Different types of grinding wheel stands are illustrated, together with dust hoods and machines for cylindrical grinding. The catalog is unusually complete and will be found of value to all users of abrasive materials.

VALVES.—The Wm. Powell Co., Cincinnati, O., recently issued the second edition of its catalog No. 10. This booklet contains considerable data on the many types of valves made by this company, together with illustrations and price lists. In addition to the tables of general technical information, instructions for the use and maintenance of the valves are also included with the description of each valve. The company has also published a condensed catalog, for the convenience of its customers, entitled Pocket Catalog A which contains the essential information of catalog No. 10.

ELECTRIC HOISTS.—An eight-page bulletin issued by the Sprague Electric Works of the General Electric Co., New York City, is devoted to the 500-pound capacity hoist manufactured by this company. It is adapted to machine shop and foundry operations, for handling castings, molds and parts to be machined. Another bulletin published by the Sprague Electric Works is devoted to flexible steel armored conductors, flexible steel conduit, stamped steel boxes, fittings and tools and a third bulletin describes alternating current two and three-phase motors and controllers for flat bed and small rotary printing presses.

SCALES.—The Standard Scale & Supply Co., Pittsburgh, has issued an illustrated catalog and price list of its line of scales. This company makes a number of heavy scales designed for use in foundries. In general, these scales are of the platform type, but are modified to meet foundry conditions. The various types include a portable platform scale with drop bearing for relieving the bearings when the load is placed on the platform. Other designs of interest to foundrymen are the charging scales for either stationary or portable purposes and the wheelbarrow scales. The complete assortment embodies types of scales for nearly every purpose, in sizes from small balance to hopper, elevator and railroad scales.

FOUNDRY EQUIPMENT.—Three catalogs, issued by the Whiting Foundry Equipment Co., Harvey, Ill., are devoted, respectively, to tumbling mills and dust arresters, core ovens and ladles. The line of tumbling barrels built by this company is well-known to the foundry trade and the catalog contains many details of the construction of these mills, as well as views of several recent large installations. A water cinder mill also is described, as well as dust arresters and exhaust systems for tumbling mills. The core oven catalog illustrates and describes this company's standard drawer and car types. A machine for withdrawing cars from ovens also is shown, as well as coremakers' benches, core oven cars and trucks. Ladles of every conceivable type for pouring castings are illustrated in the 24-page catalog devoted to this equipment.